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Elementary Mechanics—Operation of the Worm and Wheel.

BY HERMANN T. C. KRAUS.

The worm and wheel is a simple device to obtain a great difference in proportions from the driving-wheel to the wheels driven, in gaining power by expense of time. The friction of the wearing surfaces between the worm and wheel is immense, and, as they are generally rough castings, the co-efficient of friction is very great. The wearing surfaces which bear upon each other are subjected to the most unfavorable conditions, and the resistance which the worm has to overcome is enormous. It has to cut its way through, and therefore it wears out very rapidly. If it is intended for constant use, it should run in oil, in order that it may be constantly lubricated.

The worm-screw is shown in Fig. 1, driving a toothed wheel, screwing it around its axis. A single-threaded worm-screw making one revolution will move one tooth of the wheel forward a distance equal to the pitch, and, if a wheel has one hundred teeth the worm must revolve one hundred times in order to give one full revolution to the wheel. If the wheel is driving a screw, the screw will, by one full turn of the wheel move forward a distance equal to the height of the pitch.

Thus, the number of teeth in the wheel determines the number of times the worm must revolve in order to raise the weight as high as the pitch, but the diameter of the worm will not affect the result.

The thread in the worm ought to be made the thickest, and smoothed up, but the unfavorable shape of the teeth does not admit of this being easily done.

After running a little while without being overloaded the surfaces will wear smooth, and the friction consequently be somewhat reduced. This is due to the long sliding motion of the worm, which is the part from which motion is communicated by rubbing against the teeth of the wheel. If made of the same material as the wheel it necessarily wears out sooner. It should be made of a harder metal, as, for instance, steel or good wrought iron. In order to ascertain the power which can be transmitted by a worm and wheel, let us take, for example, a wheel which has twenty-seven teeth, with a pitch of, 0.80 diameter of hand-wheel, 60″, and 188.49″ circumference. The power, which is 150 lbs , is applied to the hand-wheel.

$$\begin{pmatrix}\text{Power}\\150\end{pmatrix}\ \begin{pmatrix}\text{Weight}\\W\end{pmatrix}\ \begin{pmatrix}\text{Pitch}\\0.80\end{pmatrix}\ \begin{pmatrix}\text{Circum.}\\5089''.\end{pmatrix}$$

Then 188.49 the circumference ×27, the number of teeth=5089, which is the number of inches the hand-wheel has advanced by giving it twenty-seven full turns, which will cause the wheel to make one revolution, representing the height of inclined plane. Then 150 lbs. ×5,089=763,350 lbs, which divided by 0.80 (the pitch) gives 954,200 lbs. or 477 tons for a quotient. A worm with a single thread is, in practical operation, like a pinion with only one tooth or projection, which moves the wheel forward one tooth at each revolution. The proportion is, therefore, as 100 to 1. A spur or bevel wheel having one hundred teeth, which is driven by a pinion of ten teeth, is as 10 to 1; for the pinion by one full turn will move the wheel ten teeth forward, or must make ten full turns in order to give one revolution to the wheel. It will be understood from the foregoing that the worm and wheel will transmit a greater power in proportion to the same amount of metal, than any other kind of gearing. Were it not for the immense friction of the parts it would doubtless be more generally adopted for transmitting great power by using the least amount of metal. Notwithstanding this objection the worm and wheel, when properly proportioned and constructed, has certain advantages over other kinds of gearing. To work well, the wheel should be large, the worm small, and should not run very fast, except in some cases where it is allowable for very light work.

The friction is considered as being under favorable circumstances when the teeth are well formed, so they will run quite easily together, and have the same velocity on all their wearing surfaces, so long as they remain in contact. The friction is least on a small worm, for as the diameter is increased so also is the circumference, likewise the speed in feet per second.

If the wheel is small with a coarse pitch, and the leverage for the worm to act upon necessarily short, and a heavy resistance on load attached to the wheel, the friction in the teeth is almost as much as the power necessary to overcome that resistance. Thus, with poorly-constructed teeth, not properly finished, with a large worm, and a small wheel, the friction will be about equal to the power applied.

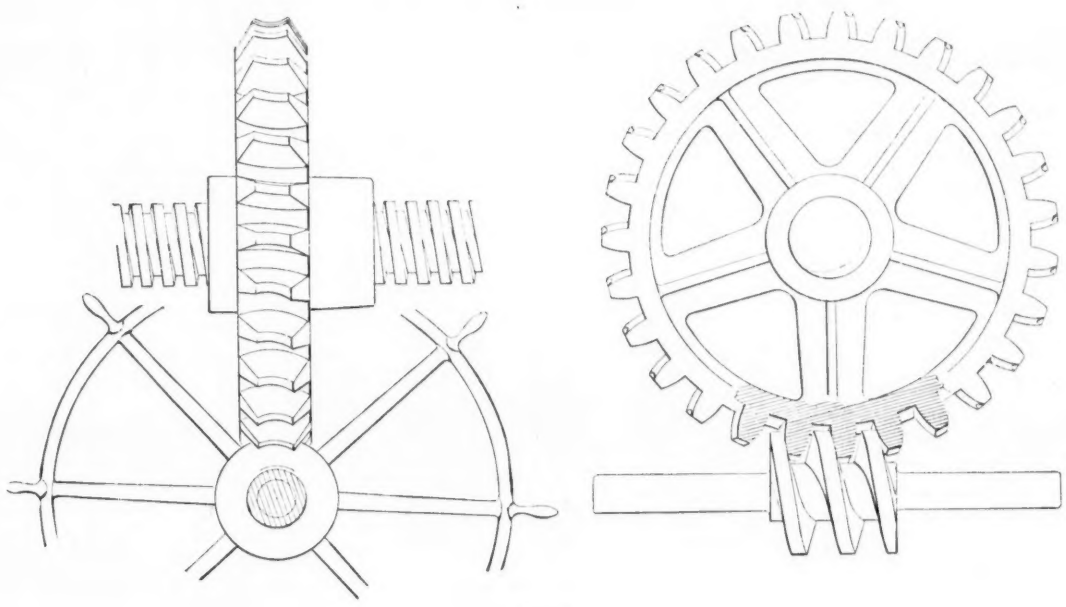


FIG. 1.

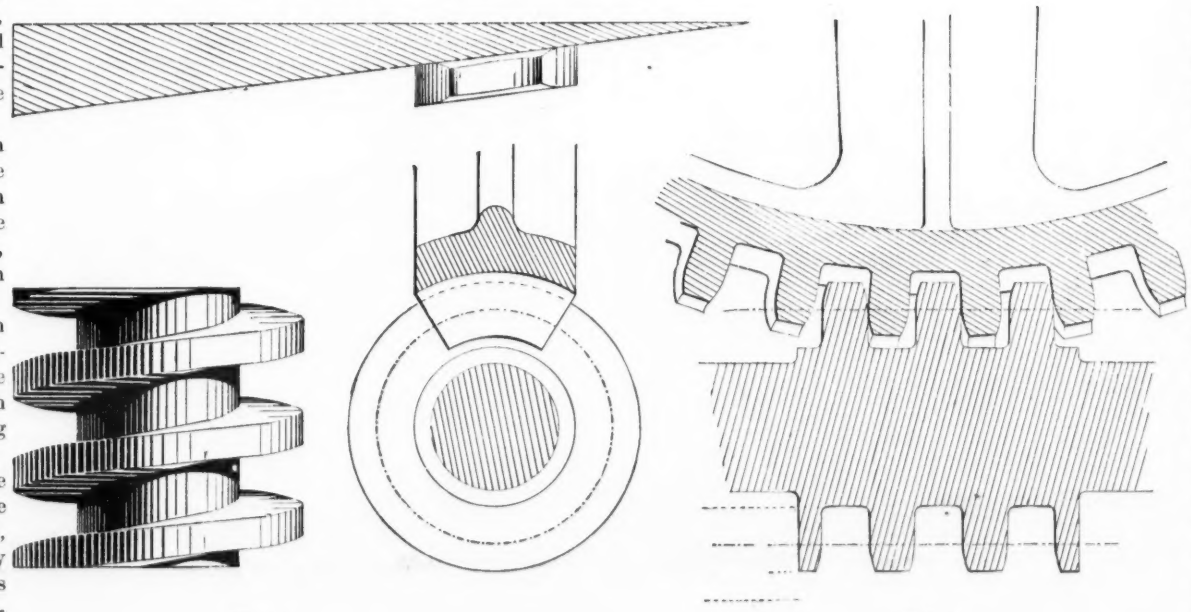


FIG. 3.

FIG. 4.

A similar result may be attained by running a worm, attached to a large wheel, at an unreasonably great velocity, in order to get the necessary speed upon the large wheel. The result is, the worm will run hot, and, owing to the great velocity and friction, the worm, though it be made of steel, will cut the teeth of the wheel, and cause an abrasion of the surfaces to such an extent as to stop the rotation of both.

I have known this to occur in several instances where the parties had wasted much time and money in experimenting. In this cutting process there is something more than mere friction, for the worm being the part which transmits the power, has to tear its own metal, which is chopped off as it crowds the wheel along, hence a very poor result.

Where economy of power is an object it should, therefore, not be employed. It is much better for transmitting motion from fast to slow, and may be used with advantage by adjusting the planes of their axis, at different angles to each other, as in Fig. 2, but in this case the worm is always the driver. In a double-threaded screw, where the skew of the teeth is much inclined, a wheel may be used to drive a worm. The diameter of the worm must be selected according to the space allowed, and the duty it has to perform. For transmitting power it ought not to be, as shown, very large.

The worm with its screw thread is looked upon as a rack or wheel of an endless diameter, while the teeth of the worm are the same as on a rack.

The curves of the teeth outside the pitch line, both in the worm and wheel, are described with a circle of half the diameter of pitch. In some cases a little less is used on the worm, as it makes the teeth more pointed. The lines of teeth on the wheel from the pitch line to the bottom are drawn radial or by a line running towards the center, while on the worm they are drawn at right angles to the pitch line. In both they ought to be rounded a little at the root of the tooth, as shown in Fig. 3. To find the inclined position or skew of the teeth on the wheel, so that it will correspond with the curve due to the pitch of the worm, take the circumference on the pitch line of the worm, and lay out an inclined plane the length of which equals the circumference, while the height equals the pitch of worm, as shown in Fig. 4, above. The worm if made by hand, should be constructed first, in order that the wheel may be fitted to it. Care must be taken to have the flat side of the wheel, and the axis of the screw in the same plane. The shaft of the wheel, and the shaft of the worm must be placed exactly

at right angles with each other; although there are wheels made with the lines of shafting at different angles to each other, care being observed in laying out to note the angle at which the lines of shafting are to run.

The manner of laying out the teeth in the worm and wheel is shown in Fig. 5. As a first step, lay out the skeleton of worm and wheel; that is, the pitch lines, also the lines above and below the pitch lines, so as to give the length of the teeth. Draw a line from the center of wheel to the center of worm at right angles to the pitch line, and where the two lines meet at the point *c*, draw a line *d*, *e*. This line forms an angle of 75° to the line *a*, *b*. Divide the radius of the wheel into four parts, set the dividers to one of these parts, and from the point *c*, set off the point *x*, then from this new-made point describe a circle which will give the curves for the teeth in wheel.

From the center of the wheel a circle is to be drawn through the point *x*, which will give the points from which the curves of all the teeth are to be laid out. This is called *the foci line*. The pitch may now be marked off on the pitch line, also the thickness of tooth, then half the thickness of tooth less $\frac{1}{10}$th part of the pitch for space, then set the dividers, and proceed to lay out the curves of teeth above the pitch line. Below the pitch line the lines forming the sides of teeth are radial, or drawn to the center of wheel. These operations are used for gearing of different diameters, and the eighth part of a circle is generally used for striking the curves for the teeth.

These curves and also the foci line may vary, according to the proportions of the diameters of the worm and wheel to each other, the curves of the teeth vary strictly with the diameter, or the diametrical pitch varies according to the gearing in contact.

Letters from Practical Men.

HOW TO MAKE "LAZY TONGS."

Mr. Editor:

In the manufacture of fire-arms, sewing machines, and various other articles where it is desirable to have uniformity and the parts interchangeable, the use of special tools, templets, jigs, &c., is indispensable, the production being more uniform and rapid, and since much skilled labor can be dispensed with, at greatly reduced cost, as compared with the old hand method.

Many things requiring duplicate parts, which it is almost impossible to make without, can, by the use of an easily-made "jig," be made practically accurate by any ordinary workman.

The following is intended to show any apprentice or amateur—and it is designed only for such—how to make "Lazy Tongs, or Parallel Rulers," that will "open out and close up nicely," and which, Chordal says, will test themselves and put a nice workman to the test.

As the same directions will answer for both—with variation in details, which any one can do for himself—we will take the "Corliss drum motion," referring to Chordal's illustration in your issue of Dec. 27.

[We reproduce the cut herewith.]

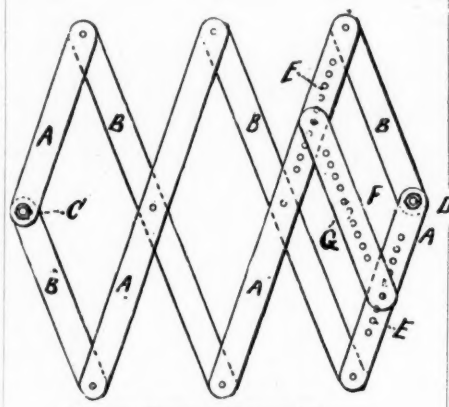
Make 6 long and 8 short strips (one of the short ones for a templet), $1\frac{1}{2}'' \times \frac{5}{16}''$ by $17\frac{1}{2}''$ and $33\frac{1}{2}''$ long, of any well-seasoned hard wood that will "stay put" when done, being careful to have them planed square on the edges, and just of a width in their whole length. For the templet, bore a hole in each end—16″ from centers and accurately in center sideways—of the size decided upon for the outside of your bushings. That the holes may be "plumb" through, make a brass bushing, with a flange $1\frac{1}{4}''$ diam., a hub $\frac{5}{16}''$ long, to go through the wood, and, perhaps, $\frac{1}{4}$ long above flange, the hole being the size of outside of bushing. Three small screws or rivets will serve to fasten it correctly to the wood. With any good bit that fills the hole in the brass bushing of your templet (one of those new "twist drill bits" is, perhaps, the best), bore one end of each piece, one at a time, the piece and templet to be accurately clamped together. Make a brass or iron pin, a good, snug fit in the holes bored, and put it through the other end of the templet and the piece already bored; clamp securely together, and bore the other end of short pieces and center of long ones. Shift pin to center of long pieces and bore the other end.

Your pivot holes being now all bored, the "hitch strip" comes next. Smaller holes and no bushings will do here. Make a hole just half way between the end holes of your templet and in the center, sideways, and another, say one inch from it, and a pin to fit this sized hole. Bore hitch strip G, by templet, shift the pin from hole to hole, and bore all the holes in G on one end only. Reverse the process, and use G for boring through templet; this is to equalize any possible error in the "spacing off," just done.

If, on examination, these holes are not all on a line and in the center of the strip G, throw it away and try again until correct. Use it then for templet to bore strips marked *E, E.* For bushings, brass rod a little larger than the finished article will probably be found the most convenient. For rivets use Stubs, or Bessemer steel wire, if you have it; otherwise, a good iron wire will answer, rubbing it smooth with fine emery paper. For the mandrel for turning the bushings use a steel rod, centered and drilled in the usual manner. Turn the end for $\frac{1}{4}''$ a little smaller than the rivets, and harden just the tip of it, letting the temper down to a full orange color. Then turn it the proper size, and it will not wear out of true in using. Cut the bushings to finish $\frac{3}{8}''$ long, bore a clean fit for rivets, and cut away the center $\frac{1}{50}''$ deep, or so, so as to leave a thin rim on the outside of each end. Fit to drive—not too hard—in the wood, and rivet down the rim level with the face of bushing, which will be a little higher than the wood, for clearance. Put caps on the rivets, and don't rivet too close. Make the two end points of steel, a little taper and pointed on lower end. Turn pins for hitch plate with ball heads and collar below them, and the thing is done.

If your strips have been straight, and of a width throughout, all the holes in the center sideways, and thus on a line; if your bit has filled the hole in the templet; your steady pin filling both holes—and your bushings turned true, and fitting the wood, it will "work just right every time."

Boston, Mass. A. N. SILL.



"LAZY TONGS" DRUM MOTION.

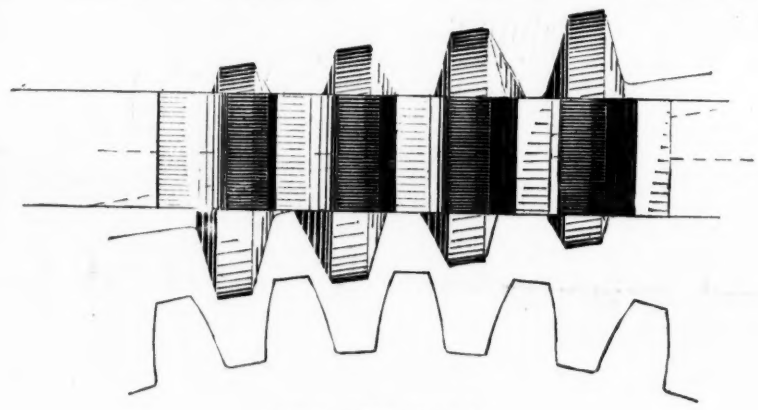


FIG. 2.—SEE PAGE 1.

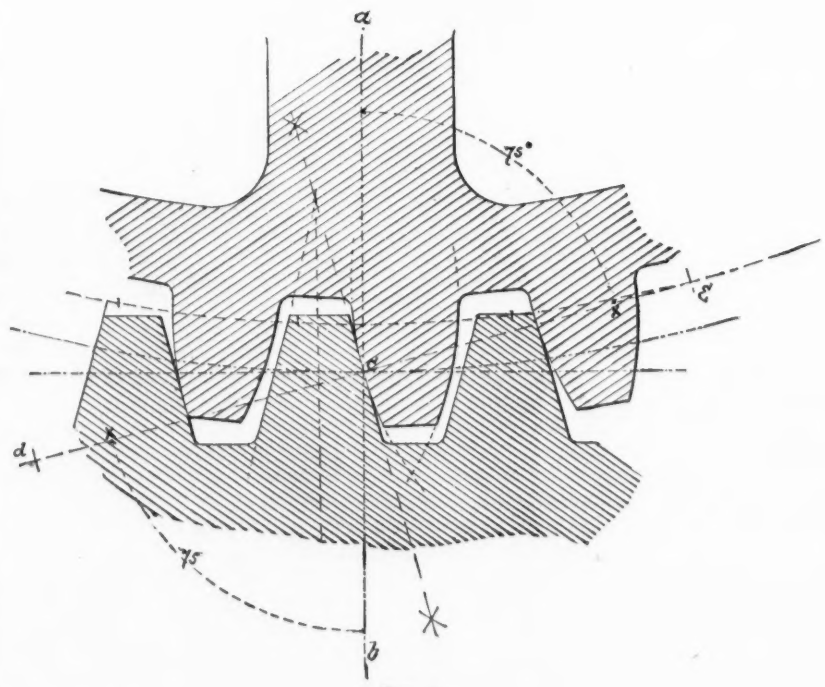


FIG. 5.

SQUARING LOCOMOTIVE FRAMES.

Editor American Machinist:

As I don't think the question which some searcher after information asked has been answered yet, by either of the articles which have appeared in the AMERICAN MACHINIST, I will send something like it.

The question was, "What is the best method of squaring Locomotive Frames and Driving Boxes?"

The articles by V. Hook and B. M. Healey are from a builder's point of view; that's all right, but I suppose that the man who asked the question was a repair man, and, if so, he has not had his answer. And, at any rate, as the frames of every new locomotive are squared a number of times after the builder has lost sight of them before they are put on the scrap-pile, I feel that the methods of squaring them as followed in the repair-shop is what is wanted.

I would rather some one else would open up this matter, but I will pocket my *modesty* and give you my plan, or rather the plan I use.

I have a straight sliding frame with steel points on ends; one point round and sharp, the other wedge-shaped. After the frames are overhauled and pedestal-caps refitted, I find that the top center casting is exactly in center of frames or cylinders. Now, we are ready for business. I find the center between frames at cylinders, and mark with a center-punch either on center-casting or back of cylinders. Next I put a straight edge across the faces of front, main pedestal legs. (I am assuming that the wedges are on back of pedestals). I then tram from center made on center casting or cylinders back to angle formed by inside edge of pedestal leg and straight edge. I then carry my tram across to the other pedestal, and try it at that angle. If both tram alike, your main pedestals are square with engine truck center. (I am not sure about the geometric correctness of this expression.) If not, I put fingers under straight edge until both do tram alike; then put up your main shoes, putting as much liner under the shoe as is under the straight edge, and from the faces of these shoes tram for your other pedestals. Put up your boxes, working all the time from these surfaces.

I have found this to be the simplest and most satisfactory method that I have tried. There are many other ways in use; some want lines drawn through both cylinders, and I am aware that there are many good mechanics who will be horrified at the idea of anything else, but life is too short for all that.

I will close by asking the practical locomotive repair-man this question:—Of all the new locomotives you have repaired, put up either by scribe or template, how many have you ever found that were *square?*

Sunbury, Pa. ALONZO DOLBEER.

"The Fitchburg" Steam Engine.

The advancement of practical knowledge as to the uses and abuses of steam, in connection with the means of transforming it into available work, has had the effect of stimulating different engine builders to exert their best efforts, and put to use all their talents, to either perfect the engines they have been making, or to design new ones in accordance with the latest principles of steam using theory and experience.

It is argued by eminent engineers of the present day that, from the uncontroverted experience of the past few years, other things being equal, the greatest economy in the use of steam is gained by using, for a given power, a cylinder small in diameter in proportion to those heretofore in common use, and, at the same time, a sufficiently high piston speed to make the work in foot pounds the same. In theory that gain should hold good to absurdly small cylinders and teriffic speeds of piston, but practically piston speed must be confined below 800 to 1,000 feet per minute, owing to the fallibility of all metals. In fact, in the light of the most recent experience, it is safe to limit piston speed at 500 feet for smaller engines, and 700 ft. for larger engines up to 1,000 horse power—a speed double that which was considered the limit but a very few years ago; an engine thus requiring a piston with but half the area, and therefore, but half the radiating or condensing surfaces, the latter accounting in part for the economy attained.

In automatic cut-off engines, a second important point is, that the waste or clearance spaces contained between the piston head, at the end of its stroke, and face of the valve, should be reduced to the smallest possible per cent. of the piston displacement, in order that in early cut-offs the terminal pressure of expanded steam may be the least possible in proportion to the mean effective pressure throughout the stroke. In fixed cut-off or throttle valve engines this consideration does not necessarily hold, as by a proper proportion of the valve gear it can be nearly or quite obviated by compression at the end of the stroke, compression, also, having a valuable office in automatic engines.

In order to get the necessary high velocity of piston in such engines, there must be a compromise between too long and too short strokes, the former requiring a long and un-

rigid bed or framing, the latter giving too high a number of revolutions to allow the centrifugal and reciprocating forces to be properly controlled. The proportion adopted in the engine we here illustrate, is that of a stroke twice the diameter of piston, and a piston speed of 500 feet per minute for a 10-inch cylinder, increasing as powers increase to 600 feet for a 24-inch cylinder. There is also necessary a positive valve motion with such high speeds, or one which is not dependent upon the force of gravity alone, or assisted by a spring, but which at any number of revolutions, has the same sure opening and closing of ports. In the engine here shown, named "The Fitchburg," and built by the Fitchburg Steam Engine Company of Fitchburg, Mass., there are used entirely independent valves for the live steam and exhaust, so that, at whatever point steam may be cut off, the exhaust, release, and closure remain always the same, can be adjusted to exactly fit the circumstances in which any engine may be placed. The valves are of the balanced piston type, the seats being reamed and valves ground and "lapped," to a perfect fit, the weight of the valves being taken upon hardened steel spindles running in hardened steel bushings.

This company has probably the largest experience in the use of the piston valve of any firm in the country, as it has been used upon the well-known "Haskins" engine built by the same firm, for the past ten years, and in that time has fully proved its great value.

As steam is taken between the ends of the valve, the stuffing boxes need packing only very lightly against exhaust pressure.

The exhaust valve obtains its fixed or constant motion from the usual simple eccentric and straight connections, its action, to accommodate different circumstances, being varied by changing the relative position of the eccentric upon the shaft and setting it fast.

The cut-off valve is also actuated by a simple eccentric and straight rod connections; but the action of this eccentric is automatically regulated by the governor, so as to admit more or less steam as speed decreases or increases, by reason of changes in load or steam pressure. The governor is fixed upon the shaft and rotates with it, its parts being contained in a disk case, the centrifugal force of weighted arms, and the centripetal force of stiff-coiled steel springs (resisting the outward movement of the arms) being so connected to the movable eccentric as to properly control its movements, as described before.

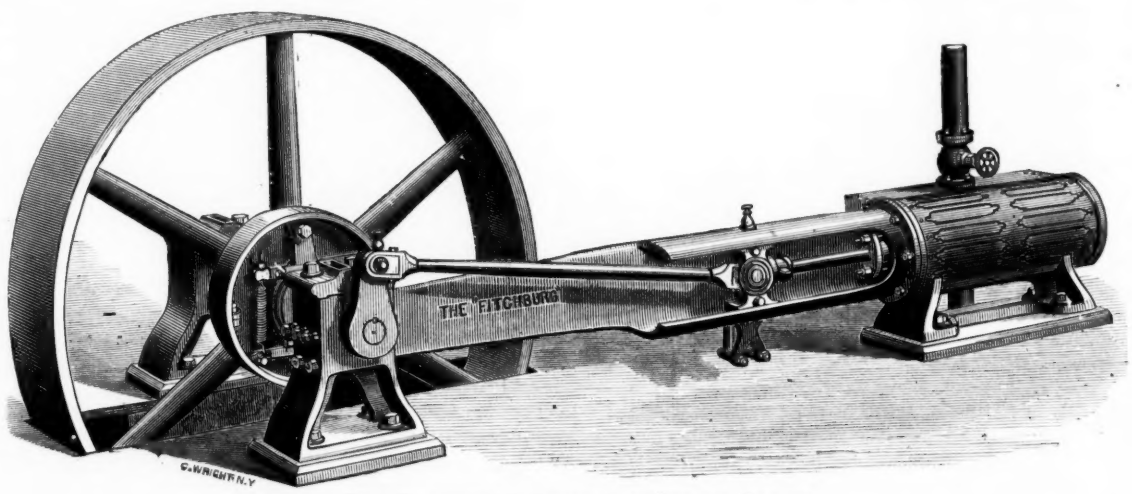
As the control of the engine is thus dependent only upon the quick action of a "live" spring, changes of load, even to the full power of the engine, are instantly detected by it, and the steam is at once admitted according to the need of the power to be exerted.

The parts of the governor have but the slightest motion upon each other, limited to one-eighth of an inch in any case, and this only when load changes very materially, so that being made of steel, and of the nicest workmanship, they are almost beyond danger of being ever worn out or accidentally destroyed.

The valves of the engine are placed very close to the cylinder and use straight ports into it, reducing clearance to from 2 to 2½ per cent. of piston displacement. The cylinder is jacketed with a thick coating of a non-conducting compound, surrounded by iron or wood lagging, reducing radiation to its lowest point. The working parts are all claimed to be made of the best materials.

The whole engine is one of those exemplifying the high speed principles which are everywhere gaining favor with progressive engineers.

The builders are willing to furnish all information desired to those contemplating the purchase of an engine.



"THE FITCHBURG" AUTOMATIC CUT-OFF ENGINE.

Extracts from Chordal's Letters.

Mr. Editor:

* * * * What do you think of a man who will work for nothing? Of a man who will get up in the night and tramp off to a machine shop with a tin bucket on his arm; who will put on overalls at seven o'clock in the morning and keep them on till six o'clock in the evening; who will stand at somebody else's lathe, or planer, or slotter, or vise, and hammer on somebody else's pieces of iron all day long, and keep it up day after day, and week after week, and month after month, and year after year, from the time he goes at the trade, at fourteen years of age, till he dies; and all for nothing? I don't mean the kind of men who find delight in seeing crude material develop and grow into useful finished products; but the kind of men who have no earthly interest in development and growth, and don't care a cent about useful finished products. Do you know any such men, working through their whole lives, and bringing the sweat at every blow—and doing it all for nothing? I know them; lots of them. There are a hundred thousand men, working in machine shops to-day, who cannot show twenty-five cents for the last twenty years' work. They have worked every day, and have drawn their pay. But where is it? They have had no grave calamities, no bad debts, no heavy losses on indorsements, no forfeited bond for a friend in office, no; nothing which impoverishes men, but everything which makes men independent, to wit: income, sure and steady, and to be depended on every time. Of these hundred thousand men I speak of, over fifty thousand haven't got ten cents in their pockets at this minute, and won't have till next pay-day. They will work day after day, and draw pay after pay. But when they leave one job and travel, do they take any of this good money with them? Not much. They borrow to pay for the trip. These same hundred thousand will raise a row to get ten cents a day more, which is right in principle; but I want to know what becomes of this ten cents. They used to get thirty and fifty cents more, but they can't show that the old figure produced any tangible results.

* * * * It won't do to say broadly that men spend their earnings in drink, etc. It won't do, for two reasons: First and foremost, it ain't true, and second and hindermost, that's a good way to spend money, if the sole object is to get rid of it as soon as possible, and that in reality seems to be the main object with the hundred thousand.

* * * * I tell you, Mr. Editor, and I can prove it by every "dead-broke" machinist in the land, that the reason the hundred thousand are always "strapped," is not because they drink, or smoke, or gamble, or wear diamonds, or keep fast horses, or nice places in the country, but simply because they don't know what to do with their pay. Let one of these fellows draw a month's pay. He goes and pays bills he owes; invests something in the worst clothes he can find, and keeps the rest in his pocket. It begins to fester right away. I tell you, Mr. Editor, that a working man, with a few extra dollars in his pocket, often has really painful desires to find something to spend a little something on. He can't think of anything he wants, and feels the existence of a void. In a few days the stuff is gone, and then some necessities arise. Credit is drawn on. Small quantities of second-class necessities, on credit at a high price, is what uses up the cream of the next pay. I have known a well-paid machinist to get eight pounds of heavy brown sugar on pay-night, when he had thirty dollars in his pocket which he had no idea under heaven what he was going to do with. The idea of getting fifty pounds of good sugar never occurred to him. Before the next pay-day, he would be getting horrible sugar on credit, by the half dollar's worth, at outrageous prices.

* * * * These very men who do no good with their money, who can't show any little fund laid up; who can't show a decent wardrobe; who never gave a friend a present costing ten dollars; who never spend two dollars on pleasure travel; who can't show five dollars worth of books; who have no wife or children made comfortable by wise expenditures; who have no balance in the office; who haven't got a hardened steel square in their tool-kit, because it costs a day's pay; who never buy good cigars, and who will buy bad whisky when tip-top whisky is the same price; these very men are the men to kick the hardest for higher pay. They will say: "I can't stay here long, wages are too low." They play hob if they find some other fellow getting five cents a day more than they do themselves. * * * * As you use discretion, Mr. Editor, in selecting extracts from my letters, I don't mind standing for an awful example. Years ago I worked for the Hall Steam Engine Company. That is to say, I put in time on their premises and got their money. I ran a planer. The aforesaid company was composed of Tom and Charlie Hall. They were not mechanics, but hailed from the salt sea. Tom had been Master, and Charlie had been Master's Mate, on some sort of a sea craft at some time, and the shop was their quarter-deck, and is now, for aught I know. They were both good men, and showed more than common sense in some of the details of their business.

In the same town was located the immense railroad shops of the Under Pavonia Railroad. These shops worked, sometimes, fifteen hundred men, and it generally happened that the men in Hall's shop were simply putting in time while waiting for some promised job in the U. P. shop. To do business with such men, you will readily see, required skill and management. Well, as before said, I worked on a planer at Hall's, and I wasn't waiting for a U. P. job either. As near as I remember, my wages were three-and-a-half a day. I worked on a while and finally learned that a German near me, by the name of Szcheinfule, or Swivel, or some such name, was getting three-seventy-five a day. Now, you know, this wouldn't do. It didn't make any difference in my finances how much money I got for my work. I had worked for three dollars and for six dollars, and it was all the same. At that time I didn't have any wife and babies, and I didn't have anything else, and no amount of wages would give me anything else. I kept grinding over the matter of this fellow getting more money than myself. I sat on that planer table and brooded and talked to myself, and got ugly. Now, whether you know it or not, Mr. Editor, machinists generally have no sense on the question of wages or business. They can't talk reasonably, and generally they put off talking till they get mad, and then they blurt out like fools. That was my case, anyhow. I kept getting madder and finally bolted into the office. The president, Mr. Thomas Hall, who, by the way, was a member of the Legislature, was there; so was the Master's Mate. I talked loud, and asked them what they took me for, and if they supposed I was going to work alongside of Swivel for a quarter less per day. Told them I knew my rights, and I wanted my pay raised or Swivel's cut down. The seafaring men waited till I exhausted my drivel, and then Tom Hall said: "Chordal, when we had our hands full of work and men were scarce, the U. P. shop came here and took all our men by offering them temporary jobs at four and five dollars per day. Every man left us but Swivel, and he didn't come in and bulldoze us for a raise either. He stayed. This thing happened not only once, but a dozen times. Swivel is not a first-class man. If we would discharge him, to-morrow we could hire him back for two dollars a day; but he has acted square with us, and men like you may come and go as much as they please, but this man Swivel will stay at the same wages he gets now. We are paying this man for what he has done for us. If you ever prove yourself worthy of such a compliment, we would be pleased to have you let us know it. We advise you to go and sit on that planer another day, and to-morrow, if you think it wise to be silly, you can do so." My better judgment prevailed, and ever since then I have always had a great deal of respect for a machinist who, without any nonsensical self-abasement, could assure himself of the respect of his employers.

* * * * While I think of the Hall Steam Engine Co., let me tell you of another case: A young fellow came to their foreman, Rogers, and asked for a job. Rogers said he was sorry, but he could not possibly scare up a job. The fellow said he had been to the U. P. shop, and there wasn't the ghost of a show there. He went off. The next night Rogers and myself were drinking beer at the Tivoli Garden, and who should come with our beer but this same chap who had asked for a job.

There he was with a white apron, and about sixteen glasses of beer. Now, while a machinist is queer about his pride, he always has lots of it, such as it is.

This thing touched the three of us.—Rogers, on inquiry, found that the fellow was "dead broke," and that this was the only thing that had opened up. He was getting a dollar a day of sixteen hours. Rogers told him to take off that apron and square up with the house. Told him to come to the shop in the morning and he would find him a job as a laborer, and as soon as there was a chance he could have a good job. The fellow came, and was set to work unloading coal-car lumber.

On pay night this same fellow raised Cain, and quit incontinently because he only got two dollars a day when men in the shop were getting three and a half. He knew his rights, you know.

* * * * It is true, Mr. Editor, that the balance on hand is a real source of annoyance to the hundred thousand machinists I have referred to. Some will read this, and I defy any one of that number to deny it. A man with a big family accumulates money and property at a dollar and a half a day, and a man right alongside of him, at three dollars and no care, never has a dollar to his name, and never has a dollar's worth of goods to show, and he don't drink unreasonably and he don't gamble. Between you and me, I think this is just as important a question to many of your readers as the question of how to make a fluted reamer which won't chatter. What does a man need to care about the chatters, if the reamer don't bring in any returns? The object of life is to make a reamer which won't chatter, and to be able to show some of the comforts and pleasures of life as the result of having made a good reamer years ago.

* * * * You may be able to make some extracts from my next letter which will bear on this same subject, and if they should result in two machinists paying county taxes, you, Mr. Editor, and myself may feel that we have done some good in our small way. * * * Very respectfully,

CHORDAL.

Talks—Indicator Rigging.

BY WM. LEE CHURCH C. E.

Chordal has spread himself on Indicators, and the touching way in which he puts up his plaint,—"Oh, for a handy rig to carry around!"—brings the unbidden tear to my eye. That is often the way with these old associations and tender memories, you know.

But Chordal will never find the handy rig: the word "handy" is what prevents it. The poor Indicator Tramp has to fall back on spontaneous genius for his reducing motion every time. The variety of cases is legion, but the worst case of all is when the boss wants his engine indicated immediately, but won't hear of shutting down a minute to give you even a chance to hook on to the cross-head. And this is a painfully frequent case too in these booming night-and-day times when every turn of the crank drops a nickel in the till. So what will we do? Well here is one way that comes very handy in surprisingly many cases. Suppose an old-fashioned box-bed engine. Rip out a piece of inch stuff say 3″ wide and 3′ long for a standard, marked *A*, in Fig. 1. Also a wedge *B*, say a foot long, and tapering from 2″ down to 1½″. Nail the steady rest *C*, say 2′ long, about mid length of the standard, and tack on a little block *D*, of the same thickness at the top. Nail another strip *E*, say a foot long across the bottom of the standard, and have a similar piece *F*, at hand. Now hold the whole thing up so that *E*, bears against the under side of the top flange of the bed, then with the wedge in the position shown in dotted line, nail on the strip *F*, with the right slant. Now if you drive the wedge home, the whole thing will stand solid. It should preferably stand as near the guides as possible. Now get out your swing lever *G*, rather wide at the top and reaching down to the guides. Pivot it on a screw *a*, at the top, preferably near one corner, so that if your cord don't lead off square, you can set the other screw *b*, enough to one side to make the cord come square with its radius *a b*, when the lever hangs plumb. Now put a final and big screw, —may be nail,—at *c*, in the little end of the lever, said screw standing cocked a little away from the guides and at about the level of the oil cup on the cross-head. Now for business, and the engine all the while a-going.

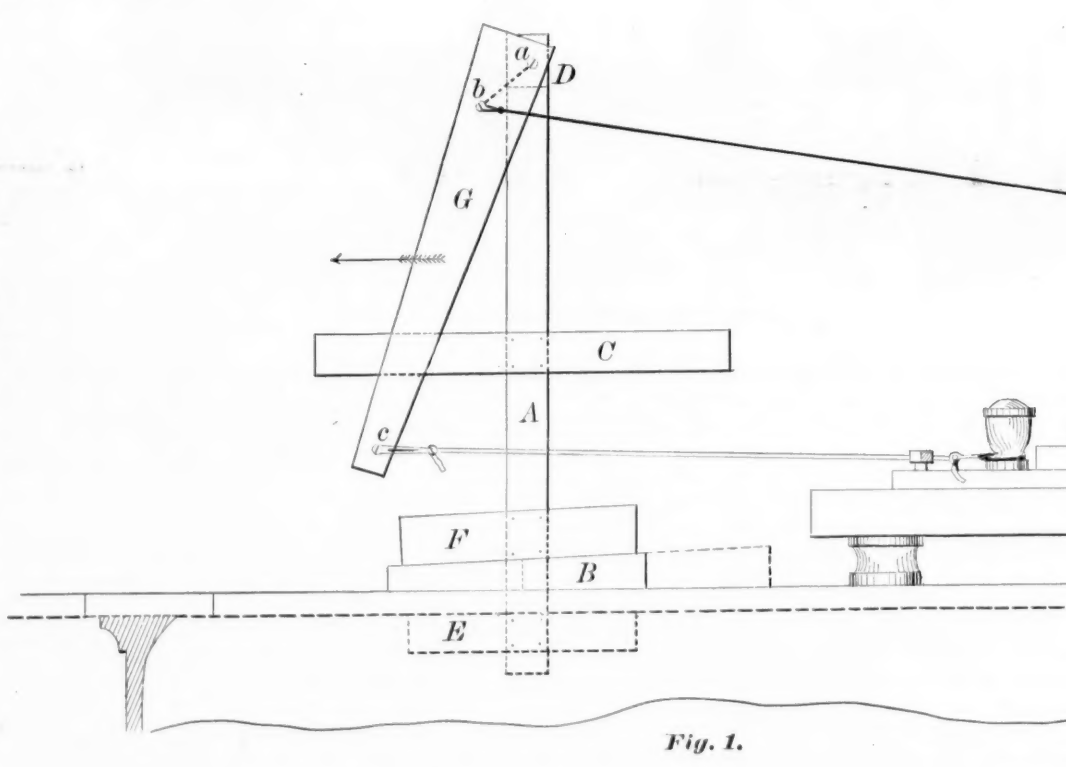


Fig. 1.

You are supposed to have laid in with the engineer last Saturday night to screw a couple of valves,—angle valves are best,—into the cylinder in place of the plugs, if his boss don't know enough to keep them standing all the time. If you didn't lay in with him as aforesaid, you will now have a degree of fun in getting the plugs out and the cocks in between strokes, which it passes my clumsy pen to describe. Dodging rain drops is lazy to it.

Well, the indicator is coupled in place, any how, and next you get a piece of good stout packing cord *H*, and tie a 4 inch loop in each end, making the length equal by the eye to the distance from the standard to the cross head oil cup,—or one of the gib screws,—at mid stroke. A knot or two will bring it fine. You further provide yourself with a Stalwart Assistant for purposes herein after noted.

Now you hook one of the loops to the lever and with the other loop you reach with confidence for that oil cup: and in four seconds you have lost the bark from both sides of your knuckles. Whereupon you retire for a season and vituperate. Ah! you have it now! You will spread the loop over the back of your extended fingers, and having got a grip on the oil cup, you will let the loop slip off on to it, while your hand follows the motion. You make a gingerly approach this time, and carry out the programme perfectly: —and the string breaks in the middle. The next time the nail jerks out. The next time the string jams in the guides. You now offer some general objurgations extending back to and including your ante-maternal relative. Refreshed, you tackle it again and the cord straightens up like a fiddle-string and distributes a plentiful donation of grease over your piccadilly. About this point the engineer sidles up and insinuates that "perhaps he can do it." He does it; with exasperating ease, and you hate him with an undying hatred. He hasn't followed up the cross head with a squirt-can for ten years for nothing, and you learn that there are experts and experts.

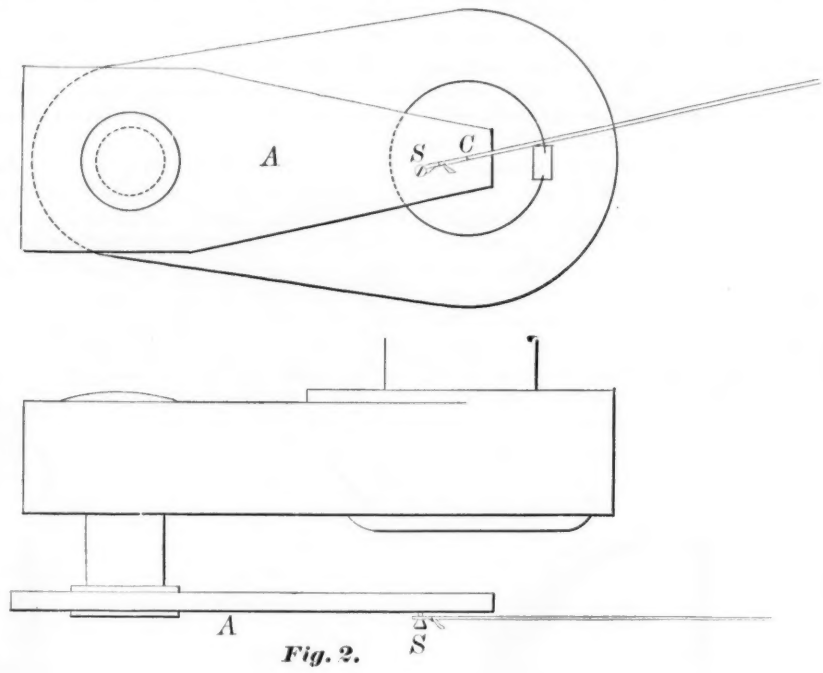


Fig. 2.

Stalwart Assistant now grasps the lever above the middle and bears away from the cross-head, as shown by the arrow, hard enough to keep the back lash out of the string, while you hook up and proceed to take cards with composure. Said composure does not seem to extend to S.-A., who suggests that the thermometer is 190° and rising.

The first time I tried this rig was on a coltish little engine, which was steady enough when hard at work. Al. was very anxious to assume the character of the Stalwart, which he did with satisfaction to all parties, till they happened to throw off the big calenders up stairs, when the little engine incontinently took the bits in her teeth and ran away, and in seven seconds poor Al's legs were snarled around his neck We separated him tenderly, but since then Al. seems to think his style of beauty is best adapted to taking the readings from the steam gauge.

Some engines persistently refuse to be indicated. Of this sort is that wretched contrivance with the steam chest hoisted up on the back of the cylinder, and the guides bestraddled with a complication of standards, and rock shafts, and valve stems. I usually circumvent them in the following fashion.

I get out a piece of board as shown at *A*, Fig. 2, and near one end I saw out a round hole just big enough to drive snug over the collar on the crank pin. If a jig saw isn't handy, most any kind of a hole that you can gnaw out with most any kind of a tool will do, so that it drives hard enough to hold.

A cleat across the end may be needed to keep it from splitting. Now drive the board on the pin so that it stands with the crank, and lay out the shaft center on it at *c*, by bringing it up by a square from the crank. Set the engine on the center. Draw a taut line from the instrument through the center *C*, and drive a screw on that line at *S*, 2″ from *C*, to which screw your cord is attached by a loop. It will be seen that this arrangement dispenses with guide pulleys, and gives a true motion to the cord. The offset of the instrument is usually enough to let the cord clear every thing. As a precaution it is well to score a line across the board and collar so as to detect any possible slip, which can rarely happen. This makes a very handy rig, but of course requires a stoppage of the engine.

I guess I will have to let my friends ponder a little longer on the struck-by-lightning card shown last time, as I have already occupied the floor too long.

Answer to a Criticism.

Editor American Machinist:

In answer to the criticism of Mr. F. B. Rice, in your issue of January 10th, 1880, I beg to state that I assume an atmosphere to be 15 lbs. pressure for simplicity. I assume 1728 as the expansion of water for the same reason, and, in so doing, I but imitate the following authorities:

Haswell—"A cubic inch of water evaporated under the ordinary atmospheric pressure is converted into 1,700 cubic inches of steam, *or in round numbers, one cubic foot;* and gives a mechanical force equal to 2,200 lbs. raised one foot."

Molesworth—"In common practice, an atmosphere is generally taken as 15 lbs. per square inch."

American Cyclopedia—"A cubic inch of water makes about a cubic foot of dry steam."

"Regnault's experiments under the auspices of the French Government gives an expansion of water at the atmospheric pressure 1,703."

Appleton's Dictionary of Mechanics—"To use round numbers it may then be stated that by the evaporation of a cubic inch of water, a mechanical force is produced equivalent to a ton weight raised one foot high, and that this force *is very nearly the same whatever be the pressure or temperature under which the evaporation takes place.*"

Professor Tyndall, in his lectures, always says 15 lbs. when referring to the atmospheric pressure.

The power developed by the evaporation of a cube of water should be discussed as physical, and the utilization of this power should be treated as mechanical. In fact, steam and steam engines are separate and distinct subjects, and should be so discussed.

WM. GOLDING.
New Orleans, La.

TO CHILL CAST IRON VERY HARD.—Use a liquid made as follows: Soft water, 10 gals.; salt, 1 peck; oil vitriol, ½ pint; saltpetre, ½ lb.; prussiate of potash, ¼ lb.; cyanide of potash, ½ lb. Heat the iron a cherry red, and dip as usual, and if wanted harder, repeat the process.

SCALING CAST IRON.—Vitriol, 1 part; water, 2 parts; mix and lay on the diluted vitriol with a cloth in the form of a brush, enough to wet the surface well; after 8 or 10 hours wash off with water, when the hard, scaly surface will be completely removed.

Gas stock in England has recovered from the decline caused by the announcement that Edison had perfected his electric lamp. It is reported that a new and remarkable French invention for the introduction of electric light will soon be made public.

Personal.

In a private letter just received by us from Prof. R. H. Thurston, now staying at Dansville, N. Y., he says:

"I am picking up all the time; shall probably go abroad for awhile, returning in the autumn." His numerous friends will be rejoiced to learn that he expects to be able to resume his educational work in the autumn of the present year.

The mean duration of rails of Bessemer steel is, according to experiments in Germany, about sixteen years.

A New Type of Compound Pumping Engine.

Those interested in water works matters are well aware that economy is a great desideratum in pumping engines. If the economy be considered with reference to performance only, the "duty" becomes the measure of the economy. Actual economy should bear reference to the interest on the investment, and to the cost of operation and maintenance, as well as to the duty performance.

With the same type of pumping engine the cost of attendance will be about the same without regard to capacity.

For towns of small size the problem has been to provide a pumping engine which would allow the investment and cost of attendance and maintenance to be brought down to a fair proportion to the desired capacity of the works, without detracting from the much desired "duty" performance.

The problem was one deserving and receiving the best thoughts of the best engineers of the world, and experience seems to have shown them that in pumping engines of limited size high duty did not always insure high economy.

High "duty" has involved high grades of expansion, and high grades of expansion have developed the problem of applying an attenuating force to a constant resistance, without a complication of mechanical expedients.

In an engine used for producing rotary motion, the fly-wheel as a leveler of the variations in force does not involve complication; but the direct movement of water by the direct movement of a steam piston is the most natural, and most desirable plan, and it should be a matter of regret in case rotating masses, converting and reconverting mechanism, massive foundations, etc., etc., were indispensable.

Water cannot be treated as a projectile in pumping engines, and the "reciprocating fly-wheel" is thus placed beyond reach as an equalizer of energy, though the elements seem near at hand.

The reasoning might be said to take this shape; the work is constant, therefore a constant force is called for. The force of expanding steam is not constant, therefore the force of expanding steam cannot be utilized to do the work. The mean force of the expanding steam may be equal to the work; the initial force will far exceed the work, but the terminal force will be less than the work. Hence the work will stop the instant the force becomes less than the work. We may utilize the momentum of a fly-wheel to absorb the excessive initial force, and deliver it when the force becomes deficient, but in that case we lose at once the simplicity of structure and perfection of natural motion we find in the direct acting engine, and we involve large extra expenditures for outlay and maintenance.

By this, and a continuation of such reasoning, we are led to the compound engine in which the steam does a portion of its work in one cylinder, and then expands into a second cylinder. In such an engine we do not suppress the attenuation of force which is found in single cylinder expansion engines, but by reason of an attenuating reaction on the first piston we find the force equalized to such a degree as to render expansion of practical utility for pumping purposes. The equalization may be rendered more perfect by means of a receiver between the cylinders. This receiver becomes a reservoir, the density of whose contents becomes augmented and decreased by inflow and outflow, but, owing to the addition it makes to the volume effected the variation produced in pressure is lessened.

Taken all in all, it is questionable whether the hundreds of pumping engines constructed on the compound-receiver, direct-acting plan are not the most economical pumping engines in use for water works purposes.

In the design of such a pumping engine the areas are so proportioned that the constant force exerted by the inflowing steam in the first cylinder, plus the varying force of the steam expanding from the first to the second cylinder, minus the varying resistance upon the first piston due to the reaction of the steam acting in the second cylinder, plus the force due to vacuum, if any, in the second cylinder, shall equal the work to be done.

The two steam pistons moving coincidently, the grade of expansion is dependent entirely upon the relation of the areas of the steam pistons. The relation of the areas of the two pistons are determined by the pressure of steam carried; by the grade of expansion determined upon; and by the measure of work to be done.

Such a machine being in operation, we find that a change in the initial pressure deranges the whole plan of operations. This derangement cannot be corrected by altering the measure of work to be done; nor by altering the speed of pistons. All of the relations must be re-arranged. This is, in practice, generally accomplished by judicious and skillful throttling at every point of admission; by an automatic control of the vacuum; and again by designing the engine for so low an initial pressure that future events will not be likely to present the necessity of dealing with a lower pressure, a higher one being brought to standard by throttling. How quickly all this is accomplished in rotative engines, by simply altering the grade of expansion by altering the point of cut off, still in such a case new conditions would be applied to a momentum mass, the fly wheel, properly proportioned to fixed conditions.

In direct-acting pumping engines we find aggregated an immense number of practical advantages, but we have also found present the grave disadvantage of the positive inability of having the grade of expansion altered by altering the quantity of steam admitted. The first cylinder of a compound pumping engine must be *filled*.

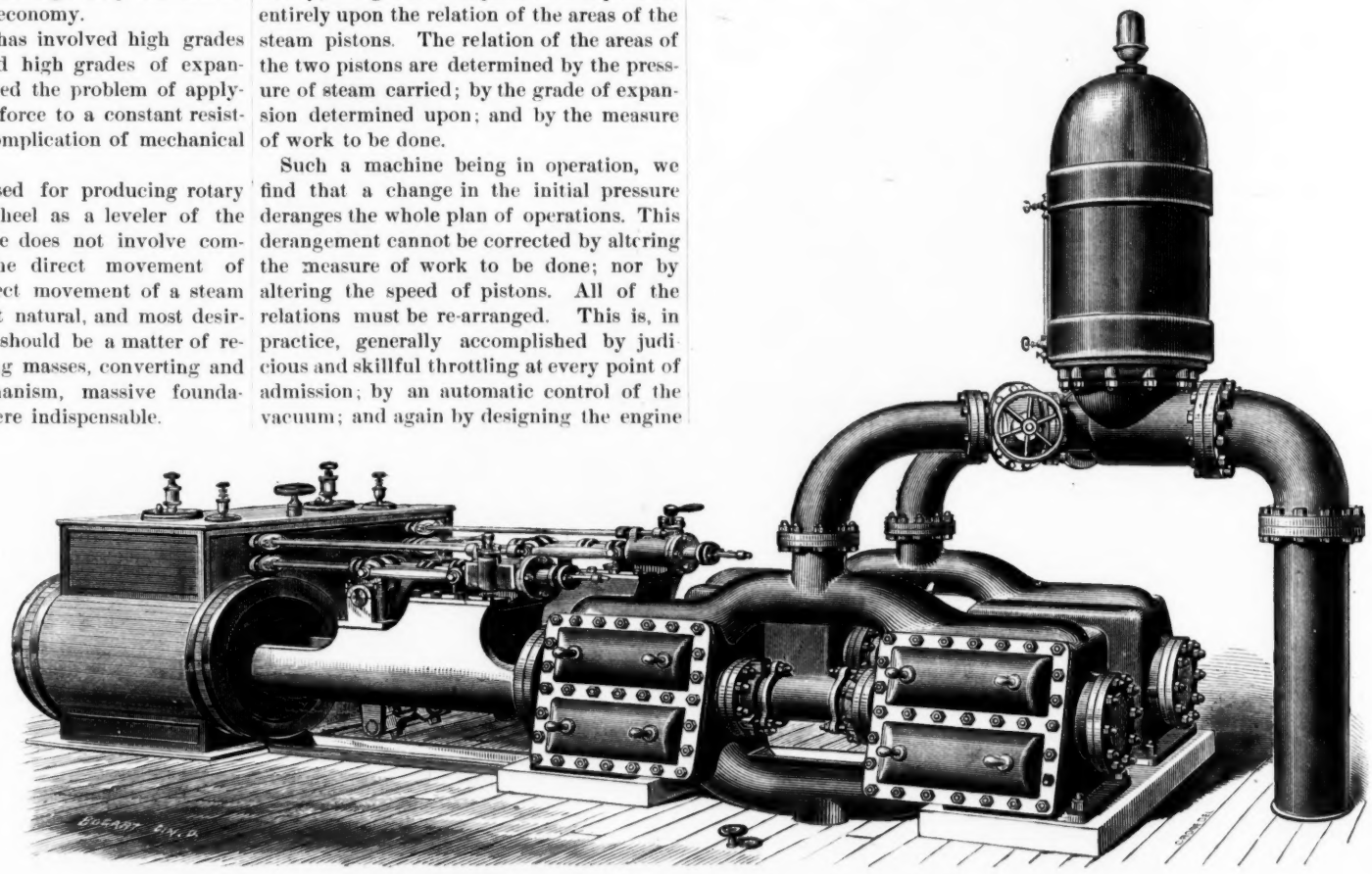
The Cope & Maxwell Manufacturing company of Hamilton, Ohio, well known in connection with the manufacture of steam-pumping engines have lately brought out a new compound-pumping engine which by reason of the novel manner, in which the steam is used, will be looked into with interest. We present an engraving of a machine of one million gallons capacity. They are constructed up to eight millions capacity. Engines of this new type are now in operation at the water works of Milwaukee, Cincinnati, East Liverpool, Ohio, and Trinadad, Col.

The machine consist of two direct-acting pumping engines delivering into one main. There is no connection between the two save by the steam pipe and water discharge. Their motions are entirely independent.

In our No. for June 28th, 1879, we described at length the ingenious "Isochronal" device which insures a perfect regulation of speed to a pumping engine. In the present case the first engine is provided with this governing device. This first engine receives its steam as usual, and exhausts it into a large receiver beneath the floor. The second or low pressure engine takes its steam from this receiver and exhausts into the atmosphere or condenser. The low-pressure cylinder is made equal, at least, in power to the high-pressure cylinder. An Isochronal device is attached to the low-pressure engine, but it is so adjusted as to regulate within wide prudent limits only.

The perceptive reader will at once see that we have here a self-adjusting, variable-expansion, direct-acting engine.

The grade of expansion is varied by a change in the comparative practical volumes of the cylinders, and this change is effected by a change in the number of strokes of the low-pressure piston, whose motion is in no way dependent on the motion of the high-pressure piston. Certain pressures being required by the low-pressure piston, for the work in hand, this piston will adapt its own motion so as to maintain that pressure in the receiver from which it draws its steam. In practice, the engines are proportioned for the work, and practical changes in conditions cause a variation in the comparative number of strokes of the two pistons of not to exceed five per minute. The simplicity and perfection of this arrangement will be at once apparent, as well as the peculiar facilities afforded for the conversion of the low-pressure engine into a high-pressure engine for fire duty; also the facilities with which each engine may be used, in emergencies, independent of its fellow. In the normal operation of this machine, one throttle gives control of the whole.



NEW PUMPING ENGINE, BY COPE & MAXWELL M'F'G CO.

During the past year the German army has successfully employed the electric light in operations under water.

The Elkhart, Ind., *Review*, has had a gas engine in use for the past year. In that time it cost $96.90 for motive power, while for steam the year previous they paid $225.00. A good showing this for the gas engine.

Boiler Proportion and Construction.—Setting for Shell Fire-Tube Boilers.—Chimney-Draught, Flow of Gases at Damper, etc.

BY WM. H. HOFFMAN.

The settings for shell tubular boilers must, for the sake of economy, be largely constructed of brick; but it is, I believe, the general opinion of our American engineers, that the ordinary setting, as now constructed, has too many bricks in contact with the boilers.

In the first place, a boiler should in no way depend on the brick-work for its support; but the lugs riveted on each side of the shell should rest on upright posts, made of two pieces of channel iron, thimbled and riveted together, thus forming a light, strong, and durable column, besides providing a complete universal adjustment for the expansion of the boiler, as the *tops* of the columns are free to sway in any direction; the bases being held in a cast-iron foundation plate.

The bolts for holding fronts in position should not be anchored to brick-work, but should be secured to the first set of channel iron columns, supporting boiler.

Every fire-tube shell boiler should have two walls on each side of boiler, leaving a space of from 3″ to 5″ between boiler and inside walls, and 3″ space between the two walls. By this means a way is open for the expansion and bulging of inside wall by heat, without affecting the outside wall in the least degree, while the non-conducting air-space is a great source of economy.

Between the boiler and inside walls there should be a light flange of cast-iron, resting by wrought-iron straps on the channel iron columns, and closing the space between boiler and walls at this point, thus preventing the brick-work from coming in contact with the boiler. This is one of the most important items to be considered in setting *any* boiler.

The buckstaves for holding side-walls in position should not be of cast-iron, but of channel iron, with the flat web placed next to brick-work; the lower ends bedded in concrete and the upper ends tied together (opposite sides) by bolts one inch in diameter passing over the return-arch on top of boiler.

The return-arch should be made either of brick or blocks of asbestos, or some other non-conducting material, resting on T iron rafters, bent to the form of boiler; the return-space under arch to be not *less* than 16″

high in the clear for a 66″ boiler, to admit of thorough cleaning and inspection.

The main bridge wall, directly back of grate bars, should be wide, for strength to resist the blows from fire-tools, and hollow, to admit air in sufficient quantity to ignite the escaping gases. Just back of this bridge-wall, there should be a small combustion-chamber, about one half the capacity of the furnace, where hard coal is used, and a little more than the full capacity of furnace where soft coal is the fuel. The object of this chamber, of course, is to allow the oxygen to freely mix with and ignite the unconsumed gases drawn over from the furnace. The remaining passage from combustion-chamber to return connection at the rear of boiler should be quite close to shell of boiler, on a 66″ shell. This distance should be no more than 12″ and no less than 8″. The spaces and combustion-chambers under shell fire-tube boiler must not be too large, else there will surely be a loss from excessive radiation.

There should be cleaning-doors on one side of boiler where room will permit, but always at the rear of boiler, and these should be large enough to clean the tubes as well as the fire connection and spaces under the shell.

The cast-iron fronts must not be too thin, on account of their liability to warp, but they can be well ribbed, and thus, in a measure, prevent this trouble. Where they are bolted together, the holes should be an eighth of an inch larger than the bolts, to allow for the expansion of castings. All fronts should be made in *four* pieces, planed or chipped together. When this method is observed, they will *never* crack at the *doors* or sides from excessive heat.

In regard to chimney-draught, velocity of the gases where they leave the boiler-setting, etc. I stated in the AMERICAN MACHINIST of Jan. 10th, that high velocity of the gases at the delivery at damper flue, connecting with chimney, gave the best results in the case of the 66″ boiler; sixty-six tubes changed to fifty-four tubes, fourteen feet long. It may be only fair that I should explain this particular case more in detail:

The boiler was one of a .battery of four, all connected to a common horizontal flue 80 feet long, leading to the chimney, which was 120 feet high above the horizontal flue, and 138 feet high above the grate; chimney flue 46″ square.

Besides these boilers, there were two special heating furnaces for metals, using ordinary hard coal, discharging into the horizontal tube their gases, at an average temperature of 1000°, and consuming about 400 pounds of coal per hour.

I selected this set of boilers for this experiment on account of the great draught-power of the chimney, as I could then draw a large quantity of air (proportioned, of course, with the fuel) into the furnace and force it through the fifty-four 3½″ tubes causing the heat to impinge on *all* sides of the tubes, while yet traveling at a reasonable high velocity *in* the tube, and finally discharge the gases at a temperature of 540°, and a velocity of 136 feet per second (theoretical speed due to head) or at about 104° actual, deducting all losses by friction-bends, etc.

I may be wrong in my theory as to *horizontal tubular* boilers, but I have yet to be convinced to the contrary. There are many reasons for their low rate of evaporation, and sluggish draught is one of them. I am aware that many engineers better qualified than the writer is on matters pertaining to this subject, will disagree with me, as to quick draught and high temperature at the damper; nevertheless, after noting boilers, with draught at delivery, ranging from twenty-eight to seventy feet per second actual velocity, I am in favor of the high rate of discharge for horizontal fire-tube boilers.

The heat must be made to impinge on the tubes.

The damper is always at hand to prevent any wasteful or unnecessary discharge of the gases.

How to Turn a Ball.

BY A. FORREST.

The turning of a perfectly spherical form in a common hand lathe, is a feat that few have accomplished who have tried it. Approximate accuracy may be attained by almost any hand-lathe workman. By means of the accompanying diagrams, I will explain a method by which balls of wood, bone, ivory, brass, and other materials admitting of hand-tool work, may be readily formed, with perfect accuracy.

Fig. 1, shows spindle of common lathe, with cone-pulley, face-plate, and back-center, with piece in place to undergo the first operation. The first process consists in blocking out the material to be used into "blanks," as nearly spherical as possible by the eye alone. When the blanks are prepared, a block of some firm, hard wood is fastened on the face-plate and formed into a concave chuck. The convexity of the chuck must have a radius considerably less than the ball to be turned, as shown. When the chuck is truly and accurately formed, the "blank" is placed in it, in position shown in Fig. 1, and the back-center is brought against it, by which it is forced to a holding position in the chuck; a small metal disk (*a*) being placed between the "blank" and point of back-center. Next turn a groove around the center of the "blank," defining the desired diameter of the finished sphere, and, with a pencil, make a line in the center of the groove. When this is done, and the "blank" is turned into position, shown in Fig. 2, the pencil line becomes a guide by which to produce the spherical form by means of the tool. The surface may be taken off, to the line, on such portion of the blank as is not embraced in the chuck, and covered by the metal disk (*a*); the blank is then reversed, or changed ends with, and the other portion turned off to the line. When this is done, only the two ends before covered by the disks will be left. These are readily turned off by placing the ball back to its first position, as in Fig. 1.

If great accuracy is required, the ball should be first formed by the method described, a trifle larger than the finished ball is to be, and the process repeated, which will produce a form sufficiently accurate for a billiard ball; provided care is taken to *true* up the chuck where it bears on the surface of the work, which may be done in a moment by a light handling of the tool.

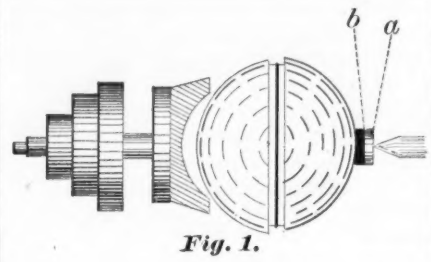


Fig. 1.

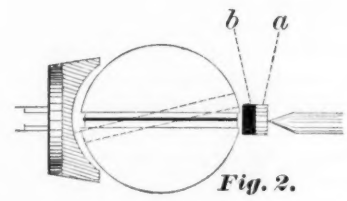
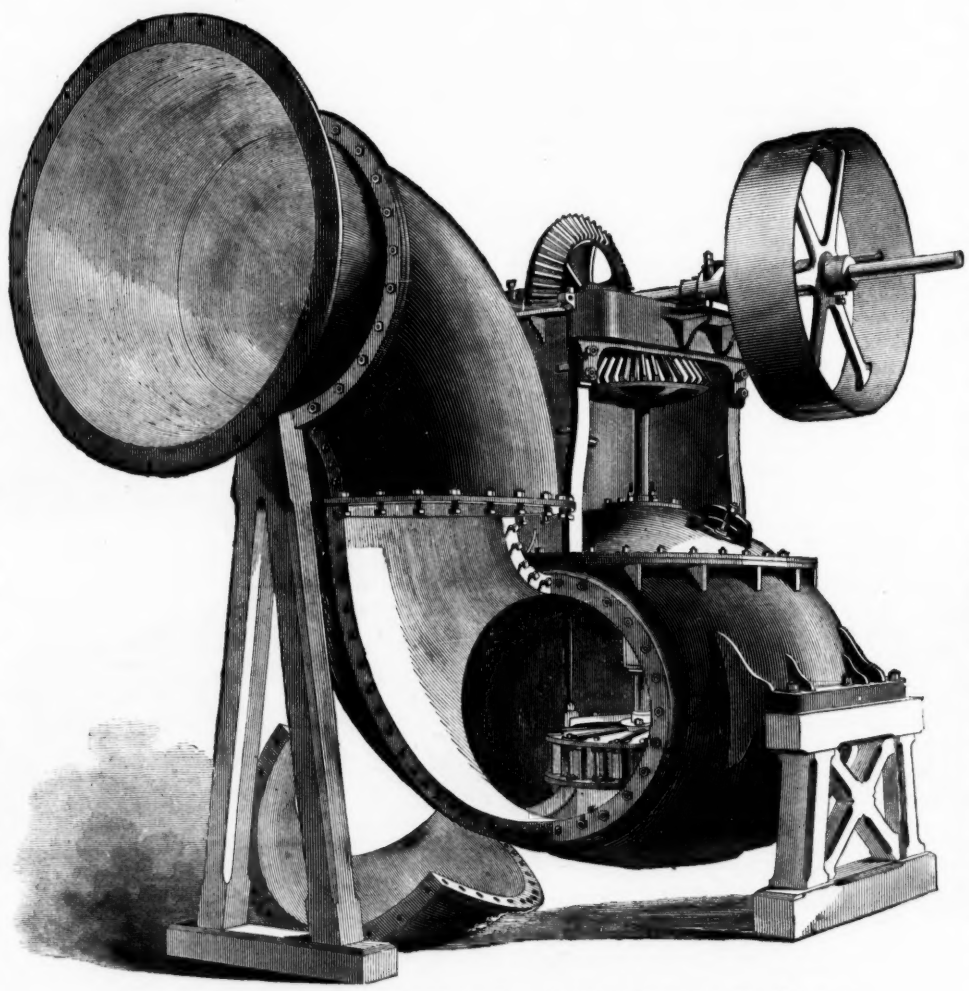


Fig. 2.

It would seem as though this method of turning balls would be successfully practical, yet trial will prove that so far as described, it is very impractical, from this fact: In the very best make of hand-lathes, it will be found that the *true axis* of the spindle produced will fall below, above, or to one side of the point of back-center, which, if the ball is held by back-center, will cause the grip of the chuck to be relieved first on one side and then on the other, every revolution of the spindle, thus allowing, or rather causing the ball to work around, and it will be found that after a few revolutions, the groove first formed will lie in position shown by dotted lines in Fig. 2, and will continue to vary every revolution, thus preventing the pencil line from becoming a guide in forming the sphere.

This whole difficulty will be overcome by inserting a small disk of rubber packing (*b*) between the ball and metal disk (*a*). This little piece of elastic packing renders the entire process successful. The facility with which the ball may be placed in the several positions described, renders the performance one of rapidity.

Fourteen acres of ground at Indianapolis have just been purchased by the Standard Oil Co., of Cleveland, upon which it will erect a stave and barrel factory.



POOLE & HUNT LEFFEL TURBINE IN CAST IRON PENSTOCK.—SEE PAGE 7.

Gleanings from the Foreign Press.

In many quarters—and those not the least informed—there is a latent distrust, or rather dislike, to machine-made articles. A case in point in England is the objection of nine out of ten brewers to use machine-made casks. By machinery, casks are turned out with an accuracy and finish unattainable by hand labor; yet but few firms have overcome a prejudice against them. When pushed home to declare the validity of their objections, it is generally found that the foreman cooper of the brewery is the real one who metaphorically throws cold water on other than hand-made articles. Further inquiry develops the fact that these foremen are men who have been accustomed to hand-labor productions all their lives, and any innovation is looked upon by them as likely to take the bread out of the mouths of the tradesmen from whose ranks they are selected. The heads of the firm naturally trust in the report of their expert, whose *ipse dixit* is considered final, and for the time being the superior article is rejected for the inferior.—*British Trade Journal.*

LAUNCH OF A SEWAGE STEAMER AT RENFREW.

(*From the Paisley and Renfrewshire Gaz.*)

On Monday, December 22, 1879, Messrs. William Simens & Co., Renfrew, Scotland, launched complete from their works a new screw steamer—of a novel build and for a novel purpose—significantly named Alpha. The vessel is of 500 tons, and is fitted with compound engines of sixty-five nominal horse power. It is in length 140 feet; breadth, 23 feet; depth, 11 feet 2 inches. The hopper capacity is 340 tons. It has been built for the Corporation of Liverpool, from the designs and under the direction of the borough engineer, Mr. G. F. Deacon. It is in some respects as peculiar in construction as the purpose to which it is to be applied is novel—that purpose to be the economical and speedy conveyance of city refuse and sewage for deposition in the deep sea, without the necessity for any gigantic and expensive intervention of conduits. In the ordinary hopper barges the sides of the well slope inward as they descend; and this construction, though answerable for heavy material, such as the dredgings of a river bottom, which forces its way out by the weight of the mass, was found objectionable when the object was to drop into the deep miscellaneous rubbish, much of which when in a dry state did not readily sink when the bottom doors were opened. It was therefore troublesome to get rid of it when deep water was reached. The plain of the new vessel differs from the Clyde hopper steamers in this respect, that the well is wider at the bottom than at the top, and instead of the body of the vessel forming one long tank it is divided into five pairs of tanks, with separate doors to each, the doors being connected with rods, which are attached to balance weights inside of vertical steel casings, and so open rapidly to allow the material to get freely away. The doors are worked on a rather novel principle. The gearing consists of a "Willans" engine, which drives simultaneously the various shafts and barrels to raise and lower the doors—an operation which can be accomplished in a very short period of time. A patent Pulsometer pump of large dimensions is fitted in stokehole with discharge pipe on deck, which can be applied to any of the tanks, to force any extra light material out through the doors.

SUBMARINE TUNNEL BETWEEN EUROPE AND AFRICA.—It has been proposed by English engineers to construct a tunnel beneath the Straits of Gibraltar, between Tarifa and Centa. The length of the projected tunnel would be about nine miles in length, and would have to be driven at a depth of at least 3,280 feet.

Railroad Ascending Mount Vesuvius.

The railroad climbing Mount Vesuvius is nearly completed, and is shortly to be opened to the public. Tourists will now be able to ascend in seven minutes to within a few yards of the crater's edge. As the inclined plane is very steep from the base of cone to the crater, it has been decided to adopt the principle of a rope railway, in which the cars are hauled up by means of a stationary engine. The route selected is believed to be perfectly secure from the incursions of lava. The upper end of the inclined plane upon which the rails are laid is 1,410 feet above the level of the station at the foot of the cone. The mean gradient is 56 in 100, and the maximum 68 in 100. The slope being very steep, and the soil composed for the most part of small pumice-stones and cinders, which slip and give way under the slightest pressure, great difficulty has been experienced in building the road.

The inclined plane was covered from end to end with a continuous solid planking, fixed on a metal framework, raised about 3 ft. from the ground, and forming a kind of immense raft which rests on the lava, and on which the rails are laid. The traffic will be effected by means of eight cars, drawn up the mountain by an endless steel wire rope, and which will be run on wheels so constructed as to be free from any danger of leaving the rails. The cable will be worked by a steam-engine at the foot of the cone. In all previous railways of this kind, the carriages have been drawn up by a single rope, but in this instance a safety-cable will be used in addition to the main cable, in order to afford security against accidents; both of these cables, previous to being put to work, have been submitted to a tensile strain ten times as great as that to which they will be subjected in practice. Each carriage will likewise be provided with an exceedingly powerful automatic brake, acting on the principle of a vise, which, in the highly-improbable case of both ropes breaking at the same moment, will instantaneously stop the carriage, and the train will be securely fixed in whatever position it may find itself. The last serious difficulty to overcome was that of ensuring the continuous working of the line.

In the midst of the lava and scoria that covered the side of the mountain, not a drop of water was to be found, and if water had been obtained from Resina, it would have cost more than wine. Considering the immense quantity of water that would be required for the use of the engine, the problem was no easy one to solve. This difficulty has been obviated by the construction of two vast reservoirs; one close to the railway station, and the other near the Observatory; and the company are not likely to experience a failure of water. By means of the new railway, 600 passengers will be able to be conveyed during a period of six hours every day.

The employees of the Ohio Falls Car Works have decided not to strike at present, but will wait until Feb. 1st, to see what action will be taken as to advancing wages.

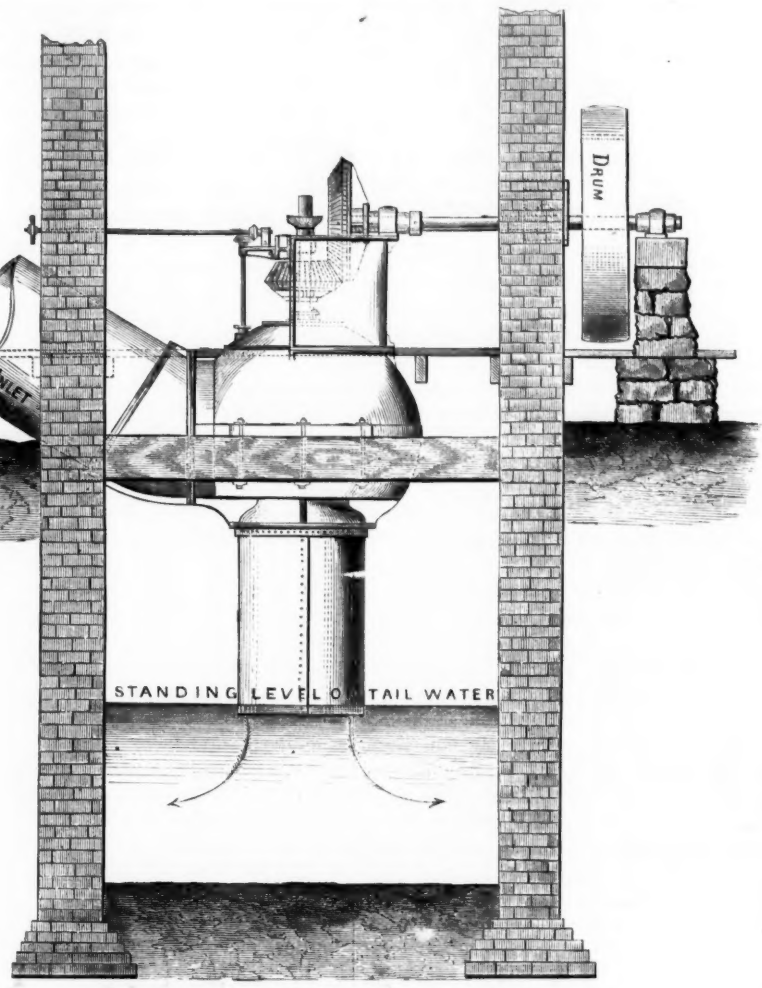
A telephone call indicator, designed to show whether any calls have been made at the telephone during an absence, is a most ingenious invention, and is being widely used in this city.—*Cleveland Herald.*

Arrangement of Leffel Turbine Water Wheels.

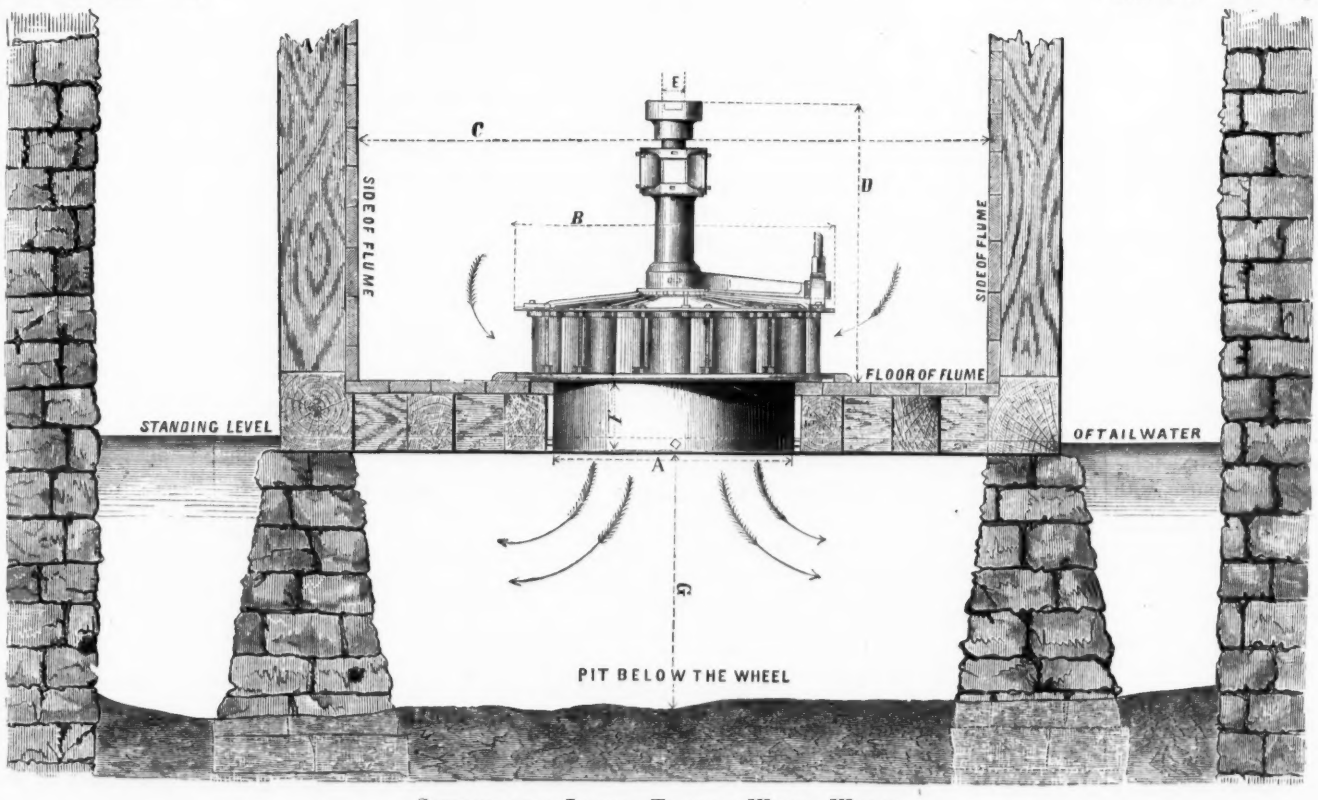
The Leffel turbine water wheel is the result of many years' careful experimenting with wheels of this class by Mr. James Leffel, a hydraulic engineer of more than ordinary ability. He constructed and experimented with over one hundred different forms of water wheels. He demonstrated that a wheel might yield a high percentage of power in a test trial, yet be wholly unfit for the ordinary purpose of manufacturing. The unsteadiness of motion, the speed and variable quantity of water used serve to detract a great deal from the working value of some turbines. Finally, Mr. Leffel constructed the double turbine, which bears his name, and which has achieved a remarkable popularity.

The engraving on pages 6 and 7 of our present issue represent different applications of the Leffel turbine water wheel, as constructed by Poole & Hunt, Baltimore, Md., who are selling them for use in all parts of our country.

The Leffel wheel is somewhat remarkable for its durability and freedom from the necessity of frequent repairs. It is built by this establishment in the very best style of workmanship. The engraving on the 6th page represents a 30½ inch wheel, fitted to a cast iron penstock, with cast iron inlet pipe, one side of a section of pipe being detached, in order that the wheel may be seen in place within the penstock. The first cut on page 7 represents a practical arrangement of Leffel wheel for driving a cotton mill. The wheel is contained in an iron spherical casing; has an iron draft tube and inlet pipe, with iron stand for supporting the head of the vertical shaft and end of the horizontal shaft. The last engraving shows the manner of flooring the pit under the wheel, when the nature of the soil is such that it would wash out from the action of the water discharged from the wheel, unless protected as shown in the cut or in some equivalent method.



TURBINE SET FOR DRIVING A COTTON MILL.



SETTING OF A LEFFEL TURBINE WATER WHEEL.

An Engineer's Presence of Mind.

The locomotive Peter B. Brigham, attached to a pay car, broke a parallel rod when about a mile this side of Messer's Crossing, on the Manchester and Lawrence Railroad, one morning recently, which came near causing a very serious injury to Engineer Charles E. Jones, and to his fireman, Charles P. Webster. The rod broke on the fireman's side, and in some way broke a steam-cock, which filled the cab with steam. Webster jumped from the locomotive, and cut his hand and bruised himself considerably. Engineer Jones, with rare presence of mind, shut his eyes and mouth tight to escape the steam, reversed his engine, put on the air-brake, and crawled through the steam back into the pay car, when it was found that his face, hands, and arms to his elbows, were terribly scalded. His presence of mind undoubtedly saved the engine from further damage, and it was set off on a side track to allow the passage of the up train, which was delayed two and a half hours by the accident. Engineer Jones was brought to his home by the up train, and is as comfortable as could be expected with such a scalding. It was a very narrow escape for him.—*Railway Review.*

The Philadelphia & Reading Co. have advanced the wages of its employees 5 per cent. making for the month of January an advance of 10 per cent. above the wages paid in October last.

A Foolish Strike.

A strike recently took place at the Newark Steel Works without the shadow of a respectable excuse. In February, 1879, the proprietors, Benj. Atha & Co. gave notice of a 10 per cent. reduction to their men. The latter struck and sent a committee for conference. A compromise was accepted by which the men agreed to sustain a reduction of 5 per cent. then, and a further reduction of 5 per cent. September 1st. At this date business had so far improved that the firm did not ask for or make the reduction. Upon being solicited by a few men for an increase the firm gave notice on Saturday night, that wages would be restored to the standard before the reduction heretofore mentioned. On Monday about 150 men in the steel mills did not come to work. *No formal demand had been made for an advance.* The firm decided not to treat with the men until they returned to work. The rate of wages they proposed to restore was the same as paid 2½ years before last spring. The average was $1.35 and $1.75 to $2.00 a day, the best men getting $6.00 a day. At last accounts the matter had not been settled, the men remaining obstinate.

THE LARGEST SEWING-MACHINE IN THE WORLD.—The Singer Manufacturing Company have just completed the construction of what is undoubtedly the largest sewing-machine in the world. The machine is driven by steam-power, and there are two needles at work, with two shuttles. It has been fitted up expressly for a manufacturing firm in Liverpool, who have orders in hand for over 70,000 feet of cotton belting awaiting fulfillment, so that the value of this mammoth sewing-machine will thus be early and satisfactorily tested.—*Ironmonger.*

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NEW YORK, FEBRUARY 7, 1880.

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Iron Prices and Supply.

Those industrial economists who, when the rise in prices of iron and steel began to attract widespread attention in the early autumn, predicted that in a short time large importations would not only check the advance, but cause a recession from the higher figures, must now accept the designation of false prophets. They confidently pointed out that the iron markets of all Europe were in a state of sore depression, and that immense quantities of the metal, both in its raw state or manufactured into bars, rods, sheets, rails, and other forms would immediately be offered to purchasers on this side of the Atlantic at lower rates than those acceptable to our iron makers should any large advance take place; thus bringing about a disastrous break in the market. The result has shown the complete folly of their predictions. Not only has the advance in our country been unimpeded by foreign competition, but every new upward movement has incited its counterpart in the great iron-producing countries of England, Sweden, Belgium, and France. Increasing importations of iron have been welcomed with zeal, not because they influence lower prices, but because they are needed to supply the enormously increasing demand. Until lately, Great Britain was the iron monarch of the world, controlling, to a great extent, the fluctuations in price of that metal wherever used in heavy quantities. Now, America rules the greatest iron markets of both continents. If there be a decline in prices in England or Scotland, it does not cause a waver in the rates fixed by the iron makers of America. Pig iron recently fell three shillings a ton in Glasgow, but directly after the receipt of the news on this side of the Atlantic, American pig advanced $2 a ton.

Our consumption of iron in 1880, is likely to be near, if not quite that of 1872, the most active railroad year ever known.

There are anywhere from 10,000 to 15,000 miles of new railroads projected for building this year, which, with the replenishing of the old roads and their appurtenances, together with that required for other uses, will call for more iron and steel than the country is prepared to produce. The chief difficulty in the way of home supply, is the scarcity of ores. Our mining industries do not seem to be able to meet the sudden expansion of demand. Many blast furnaces stand idle which would speedily be blown in were a constant supply of ores insured. We must draw very largely upon England for our iron supply until our mining and smelting facilities are much enlarged.

In this connection, we think it proper to refer to "Benner's Prophecies," published in 1875, from which we quoted extensively in the AMERICAN MACHINIST for December, 1877.

"History repeats itself," and Benner based his predictions as to the future prices of iron upon the fluctuation of the past. He found, by gathering reliable statistics, that since 1835 prices advanced three years, then declined six years; next advanced two years and declined five, and so on. The succession of advancing and declining years followed in the order of 3 up, 6 down; 2 up, 5 down; 4 up, 7 down; forming what Benner called a cycle, the last year being 1866. Again, prices advanced 3 years, declined 6 years; advanced 2 years, and had declined 4 years up to the close of 1875. In that year Benner wrote the following prophecies:

PREDICTIONS.

"I predict that the average price of No. 1 foundry charcoal pig iron in the markets of our country will be lower in the year 1876 than in 1875.

"I predict that the average price of No. 1 foundry charcoal pig iron in the markets of our country will be lower in the year 1877 than in 1876, and that the daily price in some months of that year will run below twenty dollars a ton.

"I predict that the average price of No. 1 foundry charcoal pig iron in the markets of our country will be higher in the year 1878 than in 1877.

"I predict that the average price of No. 1 foundry charcoal pig iron in the markets of our country will be higher in the year 1879 than in 1878, notwithstanding the resumption of specie payments.

"I predict that the average price of No. 1 foundry charcoal pig iron in the markets of our country will be higher in the year 1880 than in 1879.

"I predict that the average price of No. 1 foundry charcoal pig iron in the markets of our country, will be higher in the year 1881 than in 1880, and that the daily price in some months of that year will run above fifty dollars a ton."

It will be noticed that the first, second, fourth, and fifth predictions have been fulfilled to the letter, and with anthracite pig iron, at this writing, selling at $42 a ton, with a strong market, it would not be very surprising if the sixth and last should also be fulfilled. The year 1878 has been the only one of the last 45 which has not followed Benner's rule, published five years ago. If this rule works as regularly in the future as it has in the past, either 1882 or 1883 will be the first of a seven years' series of declining iron prices.

Poorly Paid Machinists.

In looking over our newspaper exchanges now-a-days we frequently are confronted with such headings as: "The Machine Men in Council," "Starting the Machine," and "The Machine at Work." Now, the unsuspecting reader who has a mechanical turn of mind may be led by these head lines to expect some practical information about improved mechanism, but nine times out of ten he is treated to nothing but a dish of gossip about the political machine. Of all the machines in use the political machine takes the most power to run it. It is as old as our government itself and has been "smashed" and repaired a surprising number of times, yet is innocent of the least improvement since its first construction. Several prominent statesmen are popularly supposed to hold patents on this machine, but cases of apparent infringement are frequently arising. The superintendents and foremen who manage the political machine, draw good salaries while it runs smoothly, but the journeymen machinists who do the work get the poorest pay of any class of operatives in this country.

The Best Weekly Pay-Day.

Every employer finds himself, at one time or another, debating the question: "What day of the week is the best for pay-day?" Saturday is the common pay-day in the majority of shops, but to this selection there are serious objections. To the objection, that workmen who are paid on Saturday are more likely to spend the succeeding day, which should be a day of rest, in hurtful debauchery, we have little reply to make, our belief being that workmen should be held as responsible, as other men, for all they do.

Men in any walk of life, when they are treated like children, and have all their thinking done for them, are liable to act like children. On the contrary, when workmen are put upon their own responsibility, and treated like rational beings, they are liable to disappoint skeptical employers by behaving like rational beings. The real objection to Saturday as a weekly pay-day, consists in the fact that on this plan, workmen and their families find the purchase and preparation of their household supplies for Sunday use inconvenient, in many cases running late into Saturday night, and unfitting all concerned for the proper enjoyment of Sunday. Friday is the day selected by many large shops as a weekly pay-day, but it is to some extent subject to the same drawback, as it is obvious that all the time spent in shopping on Saturday is to the prejudice of Sunday.

Some employers have selected Monday as the most suitable day for this purpose, alleging that it tends to prevent workmen from leaving without notice, but such an argument is as unworthy of the employer as it is insulting to the men. The convenience of his men is the chief requisite that any right-thinking employer will feel called upon to secure, in reaching a settlement of this question. And there can be little doubt that when Monday is selected for this purpose, and employees begin the week with a full pocket, enabling them to buy family supplies at their leisure, with ample time for comparison and examination, wages go farther, and life is smoother, while the employer is rewarded by better feeling and better work.

Every Man his own Locomotive.

In these days of corporate monopoly, the only chance left to the average private citizen is to organize himself into an attitude of self-protection. By means of arbitrary regulations, a few heartless railway managers hold all the remainder of our population completely under their thumbs. If Mr. Scott, or Mr. Gould, or Mr. Vanderbilt loses a favorite horse by the ravages of disease, or finds the female members of his family striking for a new thousand dollar bonnet, a single twist of passenger or freight rates makes all even, and every other family in the country finds the cost of its straw bonnets correspondingly augmented. The citizen who travels by rail from Newark or Orange to his daily business in the metropolis, finds himself fenced in by vexatious restraints, driven through narrow passageways, and compelled to show his ticket at every turn, however well acquainted with his name, residence, and private virtues, the railway despot of the car or ferry may happen to be.

In a country claiming to be free, such tyranny is not to be tamely endured any longer than circumstances may render imperatively necessary. The resources of invention, operating through the aid of steam, it must be confessed, have contributed to render this state of affairs possible; and it is plain that to invention we must look for our remedy, if we find any.

Recent improvements in the bicycling art, and late developments in the use of compressed air, offer, at least, plausible grounds for belief that these two agencies, combining together, can be made to free a large part of our population from this odious slavery to great corporations. To enable every man to be his own private locomotive, what surer arrangement can be devised than a three-wheeled vehicle, large enough to accommodate a single person with ordinary baggage, and, at the same time, by means of a suitable reservoir, carry a supply of compressed air sufficient to run the vehicle from one station to another? That such a vehicle could be devised by the inventive talent of to-day, admits of little question. That central depots for the manufacture and sale of compressed air in air-tight packages, subject, of course, to daily return for refilling, would as readily follow, is equally clear.

Perhaps, in time, even commercial travelers with sample trunks, or bridal couples enjoying the honeymoon, might be able to avail themselves of such a system.

To test the practicability of the plan, let some active mechanical genius design and put the necessary vehicle, with detachable chambers, on the market. Then, the next step would be to induce some enterprising individual, in Newark or Orange, for example, to put in a large air compressor, enabling power sufficient for the trip to New York and return to be sold at wholesale or retail, just as livery stable facilities are now sold. When this is accomplished, we shall see the beginning of a reform which, by utilizing the common roads at the rate of twenty-five miles per hour, cannot fail to bring the railway magnates of the period to a realizing sense of the fact that even the worm will turn when too long trodden upon.

Schools of Practical Mechanics.

The interest in practical mechanical schools in manufacturing districts is waking up in a gratifying manner. A correspondent writes us from Philadelphia, that the vise-work classes of the new Hand-work School connected with the Spring Garden Institute, were to be started on the 26th instant. The pupils (the oldest of which is 49 years of age) are to be taught to work "both-handed," the left hand being given special exercise to

bring it up to the standard of strength and controllability possessed by the always disciplined right hand. The director, Dr. Robert Grimshaw, adopted this plan at the suggestion of Mr. W. Barnet Le Van, of that city. An editor is among the pupils enrolled. He will probably learn to handle the file and hammer as nimbly as the quill and scissors.

Another correspondent, writing from Purdue University, Lafayette, Ind., mentions that the course of instruction in the mechanical department of that institution requires two hours per day of practical shop-work from each student, and extends over a period of two years. It is divided into four branches or courses. The first is in wood, and includes carpentry, joining, wood-turning, and pattern making. The second is a course of vise work in iron (filing and chipping). The third is forging; and the fourth, machine tool work.

The Missouri Legislature at their last session passed an act requiring all incorporated companies, the present names of which do not indicate their business, to take new corporative names, so that they will indicate the business followed, a limited time being set for the changes to be made. No one, with this fact in view, need be surprised to see the Eureka Manufacturing Company metamorphosed into the Pugsby Patent Pill Company, or the Progressive Improvement Company bloom into the Oleomargerine Churning Company.

LITERARY NOTES.

A TREATISE ON THE CONSTRUCTION AND OPERATION OF WOOD-WORKING MACHINES, including a history of the origin and progress of the manufacture of wood-working machinery. Illustrated by numerous engravings, showing the modern practice of prominent engineers in England, France, and America. By J. Richards, M. E.; 225 pages; 25 folding plates, and nearly 100 full page illustrations. Quarto cloth, $6. Published by Richards & Atkinson, 615 Walnut Street, Philadelphia, Penn.

The plan adopted by the writer has been to notice, in a general way, the several leading operations in wood-conversion with the machines in modern use, introducing such rules, and treating of such laws as have been fixed by practice and experience. This knowledge has been gathered by the writer during the course of his extensive practice in the construction and operation of wood-working machinery.

The history of wood-working machinery commences with the invention of the first circular saw mill, invented in 1777, also the first planing machine, which was invented in 1780.

Facts are given which fully establishes the date of the invention of the slide-rest as applied to the turning lathe at the present day.

A very attractive feature of the work is the progress which engineering has made, and the important part it has worked in the advancement of civilization. The nature and meaning of invention are fully described, also the general course pursued by the inventor, and the directions for a systematic way of developing an invention.

Certain speculations are indulged in bearing upon the past, present, and future of machinery.

The necessity of working to a standard system of measurements is properly advocated, and wood-working machinery has not received the proper consideration in that respect. Another important point is the relations between hand and power operations in wood-working, and the principles that govern them; also a comparison of American and English machines, with a comparison of their dimensions and proportions.

The true gain by machine work in labor-saving is fully explained, together with the difficulties and advantages encountered by combination in wood-cutting machines.

Much valuable information is given in relation to the bearings for shafts, spindles, pulleys, and speeds. The subject of sawing is discussed in all its branches, and practical directions are given for properly balancing high-speed machinery.

The subject of band sawing and its advantages are set forth, and showing machines for making cutters, with proper hints and suggestions.

In short, a man may find in this work sufficient information to enable him to fit up a factory, and having the necessary pneumatic conductors for removing shavings, and all the modern improvements.

The Paper World is a finely printed, well edited and attractive monthly publication of 56 pages, the first number of which has been issued by Clark W. Bryan, at Holyoke, Mass. It announces that it is "not a trade publication, in the general acceptation of the term, but a business journal of information, discussion and description of any and every branch of business into which paper is woven." The subscription price is only $2.00 a year.

The Railroader is the name of a sprightly, 16 page monthly journal, published at Toledo, Ohio, and containing a liberal supply of information and readable matter. It is intended to cater, more especially, to the interests of railway employees, as distinct from those of railway corporations, and fills a substantial field acceptably.

Business Specials.

Forty cents a line for each insertion under this head.

Manual of Power for Machines, Shafts, and Belts, with the History of Cotton Manufacture in the United States, by Samuel Webber, C. E., copyrighted 1879. Only work of the kind extant; 240 pages. Price $3. Address, D. Appleton & Co., New York, or the author, Manchester, N. H.

Lathe Attachments for Milling Plane and Irregular Forms; Taps and Reamers fluted and Gears cut without removing from the lathe centers. For extended description, see AMERICAN MACHINIST, Sept. 13 and 20 issues. Send for circular to Wm. Main, Piermont, N. Y.

Models made to order; experimental machinery built; parts of models supplied. H. B. Morris, Ithaca, N. Y.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common sense methods.

(1) W. S. H., Croton Falls, N. Y., asks: How are twist drills tempered so even, and left such a fine color without being brightened by friction? *A.*—Drills, reamers, taps, etc., are first hardened by heating in a bath of prussiate of potash and salt, in about equal proportions, melted (without water) in a cast iron crucible, and held at just as low heat as will answer, and have the steel harden. The degree of heat varies considerably with different kinds of steel. The temper can best be drawn by placing the articles in a tight oven kept at the required temperature, as by this method the operation may be carried on very slowly. After drawing the temper the work has to be straightened. This can be done by heating the drills up to nearly that point of drawing the temper, which makes them about as pliable as annealed steel. The imperfections or crooks are detected by rolling them over a surface plate. 2. How can I best give brass a dead black color; something that will stand handling? *A.*—Make a strong solution of nitrate of silver in one dish, and of nitrate of copper in another. Mix the two together, and plunge in the brass. Next, heat the brass evenly, until the required degree of dead blackness is obtained. This process was for many years kept a secret in Europe.

(2) C. G., Philadelphia, Penn., writes: 1. Are not machinists generally supposed to be able to do ornamental scraping on iron work? *A.*—No. A man may be considered a first-class machinist, and be only able to run a lathe or planer. Another man may be only able to do vise work, and not be able to run a lathe, and yet be an excellent workman. 2. Are not frosting and scraping identical? *A.*—No. Scraping is indefinite, and sometimes applies to very rough work, while frosting applies to ornamenting only. 3. Are there not more machine hands than vise hands at the business? *A.*—We have never heard a statement, but believe there are. 4. Which of the two (machine or vise hands) command the best pay? *A.*—The vise hand, because vise work depends upon the skill of the man, while machine work depends upon the machine. 5. Do you think rowing good exercise even after a day's work, if not indulged in to excess? *A.*—Yes.

(3) S. M., Winchester, Ill., writes: If we want to harden one piece of steel, and soften another piece, we heat them both to a red heat; the one we wish to soften we cool slowly, (and, by the way, slacked lime is the best thing I have ever found for the purpose) and the one we wish to harden we cool suddenly. Why does it harden? *A.*—It is owing to the peculiar and rapid chemical changes, including those mentioned by you, that steel has not come into more general use. These changes are very imperfectly understood, therefore we are unable to answer your question. If our readers or contributors can enlighten us on the subject we would be pleased to hear from them.

(4) C. W. S., Northport, Me., writes: In your issue of Nov. 29th, there was an answer stating that the H. P, of an engine, with dimensions as follows: Diameter of cylinder, 20"; stroke, 24"; mean effective cylinder pressure, 30 lbs.; velocity, 50 revolutions per minute, was 27,810 H. P. Now, if this is so, please tell me how you get it? *A.*—The diameter of the cylinder should have been 14" instead of 20", and was so figured, in order to obtain the results published. If you take 153 square inches, which is the area of a 14" cylinder, and follow the rule, you will obtain the required results.

(5) G. P. H., Wheeling, Va., writes: I have a machine which I wish to run at a variety of speeds, by the change of pulleys. But I wish to use the same belt at all times without altering its length. For instance, I have two pulleys 8" and 7" diameter, whose centers are 8¼" apart. Now, I wish to change the speeds of these centers, and obtain the same speeds which a 12" and a 3" pulley would give. But these pulleys alter the length of the belt, while the distance from the outside of either set of pulleys is the same, 15¼ inches. *A.*—1. You can doubtless use cone pulleys, and accomplish all that you desire. Proportions for the same were given in our issue of Nov. 15th, 1879, answer to question 3. 2. Can you give me a rule by which I can find the sizes that will suit my belt, also the proper speed? *A.*—To find the diameter of driven pulley: Multiply the diameter of the driving pulley by the number of revolutions per minute, and divide the product by the number of revolutions required; the quotient will be the diameter of pulley. To find the diameter of driving pulley: Multiply the diameter of the driven pulley by the number of revolutions per minute, and divide the product by the number of revolutions of driving-shaft; the quotient will be the diameter of pulley required. We cannot give you the proper speed unless you state the nature of the work to be accomplished.

MANUFACTURES.

Ebi & Neumann, Founders and Machinists, Davenport, Iowa, write us:

Business is booming, and fair prospects for its continuance.

The National Iron Works of New Brunswick, N. J., are busy with a force of fifty men, and are building a large mining pump to go to San Domingo, one peculiarity of which is that no one piece weighs over 100 pounds, which will enable it to be carried over the mountains on the back of mules. They are also busy on machinery for rubber works.

Wm. B. Bement & Sons (Machine Tools), Philadelphia, are running their extensive works night and day, yet are obliged to refuse some orders by reason of being too much pressed already.

A Fall River, Mass., correspondent sends us the following items:

The old Fall River Foundry and Machine Co's buildings, so long vacant, have been offered to the new Horse Car Co., for stable and car-house. The location is all that could be desired for that purpose.

A new mill, solely for weaving, will probably be erected in the spring, after the English style.

There is strong indications that the Sagamore and Border City Cotton Mills will each finish their No. 2 mills the coming summer.

Hawes Machine Co. have several men continually employed manufacturing Mock's Pat. Automatic Mule Cleaner, for which there is an active demand in our mills. These cleaners not only clean the beam and carriage, but save stopping to blow off. More yarn per week, and cleaner yarn, is the result.

The same company are at work on an order for large lathes, and several small stationary engines.

The Cutler Mfg. Co., of Warren, R. I., increase the wages of all their help from Jan. 1st.

This company is making rapid progress with the foundation for its new mill.

The Robeson Cotton Mill was fined $12 and costs; and the Merchants' $30 and costs for employing female help more than (60) sixty hours per week. These are the first convictions here under the ten hour law.

Kilbourn, Lincoln & Co. have a large gang of men at work finishing the looms for the new Union Mills; out of about one thousand contracted for, some four hundred are yet to be delivered.

The Fall River Iron Works Boiler Shop have made a contract to finish a new boiler for the steamer *David H. Wilson.*

The Chester Steel Castings Co., Office, 407 Library St., Philadelphia, (Works, Chester, Pa.) have in last few months doubled the capacity of their works by lengthening their main foundry building, and adding to it an L, 60×80 feet, and have also erected a larger furnace, larger steam engine, and boilers, etc. They are doing double the work they were in the spring. Are filling orders for Steel Castings from nearly all the Locomotive Builders in the United States, also from Railway Cos., Engine Builders, Machine Shops, and Agricultural Implement Manufacturers, and for Wood Working Machinery.

A new factory building will soon be begun on Canal St., Chicago, adjoining the warerooms of F. Mayer & Co. It will be ready for occupancy by May 1st, and it is stated that Matuska, Craig & Co. will be the occupants.

The Caledonia Iron Works, at the South Mountain, Pa., belonging to the estate of Hon. Thaddeus Stevens, will be started up in the coming spring.

A Mauch Chunk, Pa., capitalist is negotiating for the purchase of the Weissport or "Fort Allen" Rolling Mill, owned by Marshall & Bro., Phila., which has been lying idle for four years past. If the purchase is completed, as seems probable, the new proprietor will double its capacity and put it in order at once.

The Fort Allen Foundry, Weissport, Pa., is running full time on light castings of various kinds, sewing machine frames, water closets, etc.

The Lehigh Stove and Manufacturing Co., Weissport, Pa., are doing a large business. In fact, the whole Lehigh Valley is "booming," and it is believed that 1880 will be the greatest year this Valley has ever known.

E. L. Morse, St. Louis, Mo., has recently received an order for one of his feed-water heater and purifiers, No. 3, for use by the Chicago Water Works Company. He also has just shipped a No. 8 to the Davenport Glucose Works, Davenport, Ia.

The Walker & Pratt Manufacturing Company proposes soon to erect a building for a mounting shop at their Watertown, Mass., foundry.

The Franklin Foundry and Machine Company, of Providence, R. I., are using the electric light in their setting up rooms. This concern are now employing over 400 men, and have orders sufficient to last them to the middle of August or later, the demand being largely for their improved cotton spinning machinery, in which they have recently introduced many novel and useful improvements.

The Providence, R. I., Machine Company are working to the full capacity of their shop on cotton and woolen machinery.

The Barnum & Richardson Manufacturing Company, of Chicago, have refitted their car wheel foundry on 22d Street. The resuming of business at these works will be the means of giving employment to from 50 to 75 hands.

The Cutler Manufacturing Company, of Warren, R. I., have the foundations laid for a mill of 25,000 spindles, in which they are to manufacture cotton yarns.

The machinery firm of Smith, Beggs & Co., St. Louis, Mo., has been changed to the Smith, Beggs & Rankin Machine Co.

At the Delaney Iron works, Buffalo, an extraordinary feat in blacksmithing has been performed. A locomotive frame of the Brooks pattern was made in ten hours and forty minutes. This is said to be the fastest time on record.

The Peck, Stow & Wilcox Company have just completed a large addition to their foundry at Plantsville (Southington), Conn., and intend to add to their force of foundrymen.

Rick Brothers, Reading, Pa., are building a new three story brick warehouse, machine shop, pattern shop, and foundry, to cost $7,000.

Moore & Moss, Kansas City, Mo., are building a brick foundry, to cost $5,000.

D. M. Jarboe & Co., Kansas City, Mo., are building a foundry and blacksmith shop, to cost $6,000.

Fowler Bros., of Belfast, Ireland, are preparing to build a mammoth packing-house at Kansas City, Mo.

Allen & Hanoum, Clinton, Iowa, are building a frame boiler shop.

The Chicago and Western Indiana Railroad Company are building a new roundhouse.

The Machinery boom at Duvall & Co.'s works (says the Zanesville, O. *Courier*,) keeps pace with the general boom throughout the country. In order to fulfill contracts and deliver machinery promptly, this firm is compelled to keep their shops in operation from seven o'clock in the morning until ten o'clock at night—fourteen hours a day. Mechanics, who a few years ago were unable to find employment at any price, are now making nearly eight and a half days a week. The Divine injunction: "Six days shalt thou labor," is observed to the letter, but they are awfully long days. The mail brought seven orders for engines and saw mills, the first two days of this week, and including the three last days of last week, the orders on the order book for machinery aggregated thirteen in five days. Duvall & Co., by fair dealing, low prices, and first-class work, have made it an object for purchasers of mill machinery to visit Zanesville, and they have earned the confidence of the public by faithfully discharging every contract entered into. The members of the firm are all practical workmen, dividing the labor of the office and foremanship of the different departments between them.

The Lafayette, Ind., Car Works have recommenced operations. The first cars to be built are 200 for the Lake Erie & Western. The working force in the building will be sufficient to turn out eighteen cars per week

Machinists' and Engineers' Supplies.

NEW YORK, Jan. 22, 1880.

The supply business this week seems to have taken a fresh start, as the annual suspension, caused by taking inventories, has nearly passed. Preparations are, accordingly, being made for a brisk spring trade. The tendency of prices is generally upward, and some of the more prominent manufacturing firms have sent out notices withdrawing quotations on all kinds of goods and prices are given only on application.

Wrought Iron Pipe has advanced 5 per cent. within the last week. Cast Iron Pipe fittings have also advanced 10 per cent., and, it is thought, will go higher.

Sheet Brass and brass and copper wire advanced, yesterday, 2c. per lb. on list. Prices are stiffening, and the discount has been changed from 20 per cent. to 10 per cent.

A new composition metal, known as Gold Bronze, is being introduced for ornamental work of all kinds. It is very ductile and easily worked into any shape, either by casting or spinning. The color, in appearance, is about the same as 18 karat gold, and it is said to be free from tarnishing. The cost is from 5c. to 6c. more than copper. It is first cast into ingots or slabs for convenient handling.

Peter Wright's anvils have advanced to 11¾c. per lb.

Iron Castings for lathes and planers have advanced 1c. per lb.

As predicted last week, small machinists' tools, such as calipers, scales and finished goods, have advanced about 10 per cent.

The Packer ratchet has advanced from discount 60 per cent. to 55 per cent.

Prentiss' vises—also the Stevens—remain unchanged.

The prices of the Bradley Cushioned Hammers will be advanced 10 to 15 per cent. soon.

Forged goods, such as hammers and sledges, will probably be advanced from 10 to 15 per cent. shortly. We understand that an organization is now being considered having for its object the advancement of prices in these goods.

A new Giant Pipe Tongs is being introduced, the peculiarity of which is the employment of a hardened steel cube, for the purpose of holding the pipe, and when one edge is worn out, another may be presented by simply turning the cube.

In accordance with our predictions for some weeks past, the price of Cushman's chucks has advanced 5 per cent.

Taps and dies remain unchanged, but will probably advance soon, as the principal manufacturers cannot fill their orders. An effort is being made to form a combination, which, if successful, will advance prices.

The manufacturers of gas pliers say that they are smothered with orders, and cannot get steel from which to make their goods.

A new shop has lately been fitted up in Milwaukee, Wis., for the manufacture of twist drills. After experimenting for some time, the makers are said to have succeeded in producing an excellent quality of goods.

A new Adjustable Wrench for small work is being introduced, the principle of which is a hollow tube with a tapered hole, into which are fitted spring-tapered jaws. The jaws are opened by pushing them out with the hand, and are closed by a self-acting spring. It is made of steel, and seems to be desirable for small work.

A new cheap wood screw, intended for rough work, is being manufactured, which, instead of being turned as the ordinary wood screws are, is rolled. It is claimed that they can be produced for about half the price of the ordinary screw.

Brass Tubing continues to stiffen, and no list is published, or prices given by the manufacturers, except on orders for immediate acceptance from day to day. The price of copper having advanced on yesterday to 24¾ cts. per lb., the prices of tubing will, no doubt, advance about 20 or 25 per cent. within a few days.

All brass goods are certain to take a similar course, on account of the rise in copper.

Eaton, Cole & Burnham Co., 58 John St., New York, send us the following:

NEW YORK, Jan. 20, 1880.

We hereby withdraw quotations on all kinds of goods.

Prices will be given on application.

EATON, COLE & BURNHAM CO.

Peck Bros., 73 Beekman St., have reduced the discount on all brass steam fittings from 25% to 15%.

The Nason Manufacturing Company (Steam Fittings) send us the following notice:

10th January, 1880.

On account of the unsettled condition of prices for all metals, we are compelled to notify our friends that our prices are subject to change without notice, and that all quotations made are necessarily for immediate acceptance.

Orders will be entered at price current at the time of their receipt. THE NASON MANUF'G. CO.

Nos. 71 Beekman and Fulton Streets, N. Y.

The predicted advance in Machine Screws took place to-day, the American Screw Co. quoting flat head iron at 60% discount.

The American Screw Co. also quote flat head iron wood screws at 40% discount.

Iron Review.

NEW YORK, Jan. 22, 1880.

Those Iron buyers who have watched this column, and been guided by it, have been well rewarded, every prediction that we have made for months having been signally fulfilled, the explanation being that we have ransacked the best sources for information in all cases. The weight of evidence now is all one way, and all points in the direction of higher prices, which may come any moment. A speedy advance may safely be considered certain.

Pierson & Co., 24 Broadway, New York, furnish us the following quotations out of store, under date of Jan. 22, 1880.

No. 1, X Pig, $42½ per ton; Iron Rails, $68 to $70, according to weight; Old Rails $44 to $45; Fish Plates, 4c. per lb.; Railway Spikes, 4¾c.; Bolts and Nuts, 5½c.; Common Bar Iron, 3 2-10c., basis from store; Refined, 3½c., basis; Ulster, 4 5-10c., basis; Machinery Steel, 7c.; Best Tool Steel, 13½c.; Norway Bar Iron, 6c.; Norway Shapes, 6½c.; Nail Rods, 6½c.; Sheet Iron, 5c., basis; Angle Iron, 4c.; Tee Iron, 4½c; Band Iron, 4c.; Hoop Iron, 4 3-10c.; Horse Shoe Iron, 4c.; Hot Polished Shafting in lengths, 2 ft. and longer, 9 to 10½c., according to size; Small Black Rivets 30% off in papers, 10% off in bulk.

Store prices to-day of boiler-makers supplies: Flange, 6¼c.; C. H. No. 1 Shell, 5¼c., C. No. 1, 4¾c.; Sheets, 5c. basis.

Metal Review.

LUCIUS HART & CO., 8 & 10 Burling slip, New York, furnish us the following, under date of Jan. 22d, 1880:

Pig Tin continues steadily to advance in London and Singapore. At the former the price of Straits is £99, and at the latter, $32, the highest price for years, The market here fully responds. Banca Tin, 26c.; Malacca and Straits, 24½c. to 25c.; Billiton and Australian, 24¼c.; "Lamb and Flag," 24c.; Pig Lead is higher, 6¼c. the price of Newark; Antimony in less supply, and advanced to 18¾c. for "Halletts;" 22c. for "Cookson;" Ingot Copper strong, and excited here and abroad; business done yesterday at 24¾c. for spot, and 25c. to 25¼c. for futures; Spelter also is dearer; 6¾c. for domestic or foreign; Nickel, $1.25; No. 1 Solder, 13½c.; Half-and-half, 15½c. The demand for metals from manufacturers and consumers is unprecedented for the month of January.

Situations Wanted—Help Wanted.

We will publish notices suitable for the above headings, applying to any of the machinery trades, and not to exceed four lines each (32 words), at the nominal rate of twenty-five cents for each insertion.

Foreman Machinist.—A Foreman Machinist holding first-class testimonials is open for an engagement; has controlled large bodies of men; 9 months experience in States. Address, R. M. B., Schenectady, N.Y.

A young man wants to get into an engine shop with a view of mastering every branch, and becoming a thorough mechanic. Address, W. F. Davies, 3110 Market St., Philadelphia, Pa.

Wanted at the Wausau Iron Works, Wausau, Wis., first-class machinists. Apply to D. J. Murray, proprietor, Wausau, Wis.

Parties desiring a good practical and reliable machinist as foreman, who understands managing help and is well qualified for general jobbing or specialties, can find one by addressing A. S. Granville, Lawrence, Mass.

WANTED—A situation by an able and active mechanic and draughtsman of many years experience. Is thoroughly conversant with the Corliss system and the construction of special tools. First-class references given if required. Address A. P., American Machinist, 96 Fulton Street, N. Y.

WANTED—Situation as foreman over a Machine Shop by a well qualified man. Address W. Fitton, Mount Washington, Bedford Street, Pittsburgh, Pa.

Wanted a situation by a competent Mech. Eng. and draughtsman as Supt. of Machine Shop or draughtsman, address A. E. W. care American Machinist, 96 Fulton Street, New York.

By a young and energetic mechanical engineer and draughtsman—a situation in some shop where he may learn the business. Has had considerable practice. Best of references given. Address, M., Am. Machinist Office.

MACHINE
DRAWING COPIES
TEN CENTS EACH.
Send for List of Plates, now ready, and Catalogue of Books for Practical Engineers.
E. & F. N. Spon, 446 Broome St., N. Y.

The Workshop Companion.
A handy and useful dictionary of practical information for **Engineers, Machinists, Draughtsmen and Mechanics**, containing useful and reliable recipes, rules, processes, methods, practical hints, &c. **NO** medical or cookery recipes. 164 pages. This book will be sent, post-paid, on receipt of Twelve 3-cent postage stamps.
T. P. PEMBERTON,
249 Duffield St., Brooklyn, N. Y.

PATENT NICKEL-SEATED
"POP" SAFETY VALVES
FOR
STATIONARY, LOCOMOTIVE, MARINE and PORTABLE
STEAM BOILERS

Our Patents cover all Safety Valves utilizing the recoil action of steam, and familiarly known as "Pop Safety Valve."
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Capital, $100,000.
The Consolidated Safety Valve Co.,
Office and Manufactory,
51 & 53 SUDBURY ST., BOSTON, Mass.

SEND FOR PAMPHLET. THE FAR-FAMED AMERICAN LUBRICATOR. TEN THOUSAND IN USE.
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DETROIT. MICH. U.S.A.

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Vertical Engine.
For all light, quick work. Size, 2 to 20 horse power. Also,
Special Yacht Engines
And the Twiss Patent Automatic Engine.
Manuf'd by NELSON W. TWISS,
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NEWARK STEEL WORKS.
BENJAMIN ATHA & CO.
MANUFACTURERS OF
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WE MAKE GRADES OF STEEL SPECIALLY ADAPTED TO THE MANUFACTURE OF LATHE TOOLS, CHISELS, TAPS & DIES
BENJ. ATHA. NEWARK, NEW JERSEY. J. ILLINGWORTH.

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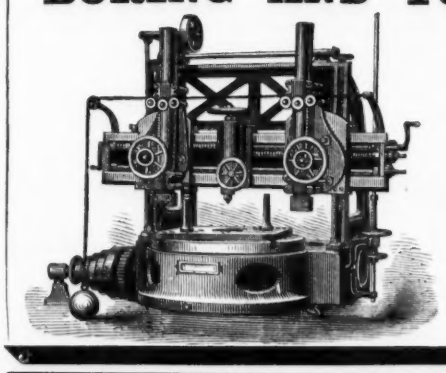
All Sizes: 4, 5, 6, 8, 10, and 12 feet Swings.
PATENTED IMPROVEMENTS.
New Patterns.
MACHINISTS' TOOLS,
The Latest and Best, at very moderate prices.
NILES TOOL WORKS,
HAMILTON, OHIO.

SHEFFIELD, ENGLAND. F. W. MOSS, 80 JOHN STREET, NEW YORK.
(SUCCESSOR TO JOSHUA MOSS AND GAMBLE BROS.)
STEEL and FILES
HAMMERS, ANVILS, VISES, BLACKSMITHS' TOOLS.
WARRANTED CAST STEEL. Specially adapted for Dies, Punches, Turning Tools, Drills, &c.
ALSO, THE WORLD-RENOWNED
IMPROVED MILD CENTERED CAST STEEL,
Specially adapted for Taps, Reamers, Milling Tools, &c.
Warranted Not to Crack in Hardening Tools of Any Size.

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SOLE MANUFACTURERS OF

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HAVING THE INCREMENT CUT.

Also, FILERS' TOOLS and SPECIALTIES.

"Nicholson File Co's" Files and Rasps.
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Handled Rifflers.
Machinists' Scrapers.
File Brushes, File Cards.
Surface File Holders,
Vise File Holders.
Stub Files and Holders.
Improved Butchers' Steels.

Manufactory and Offices at **PROVIDENCE, R. I., U. S. A.**

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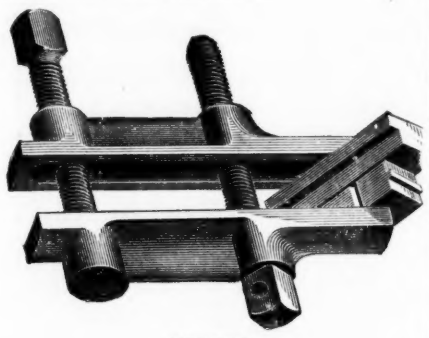
SOUTH NORWALK, CONNECTICUT,

Manufacturer of

LeCount's Vice Clamp,

With Steel Screws, hardened the whole length, a spring temper and ball head, so as to clamp an object at any angle without bending the screws. The clamps are also steel and of great strength.



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Sole Agents for the Tanite Co.'s Solid Emery Wheels, Grinding Machinery, &c.

Also, agents for Shepard's Screw Cutting Lathes Dealers in Morse Twist Drill Co's Goods and small tools for all workers in iron or wood. Send for Catalogue.

IMPORTANT TO STEAM USERS.

Great Saving of Fuel.

Save repairs and prevent explosion by using the

Peerless Damper Regulator,

which regulates the draft automatically, and controls the steam pressure. In ordering mention pressure. Illustrated Catalogue sent on application.

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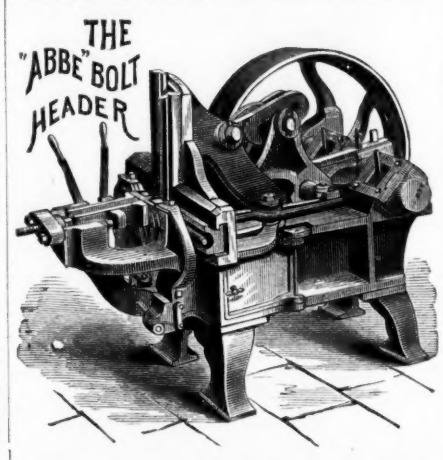

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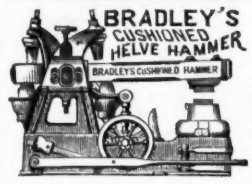

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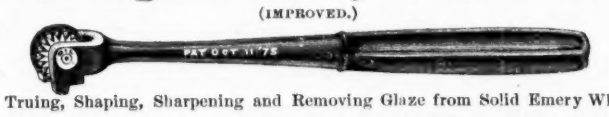

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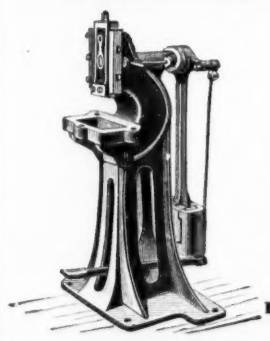

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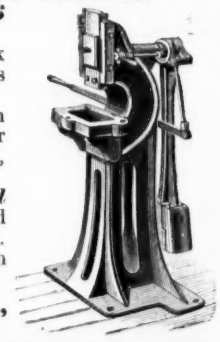

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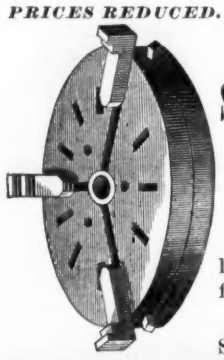

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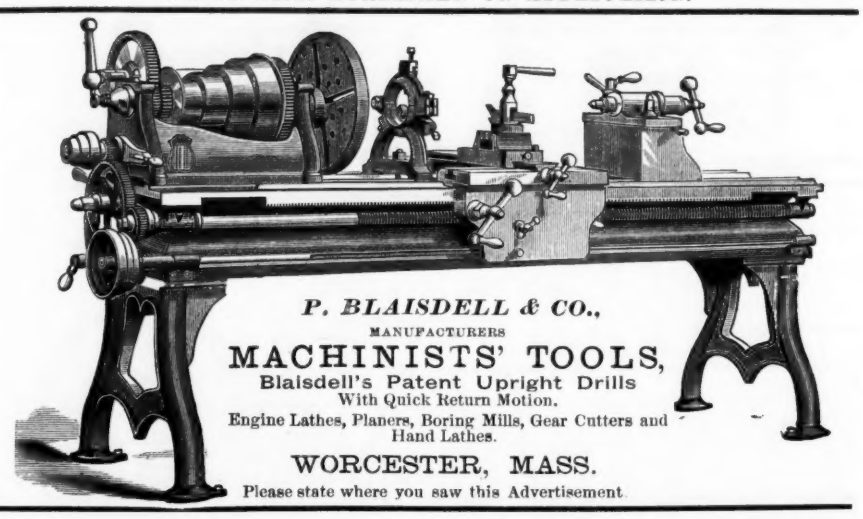

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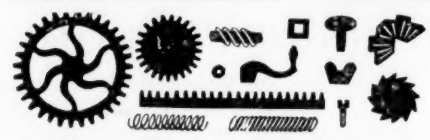

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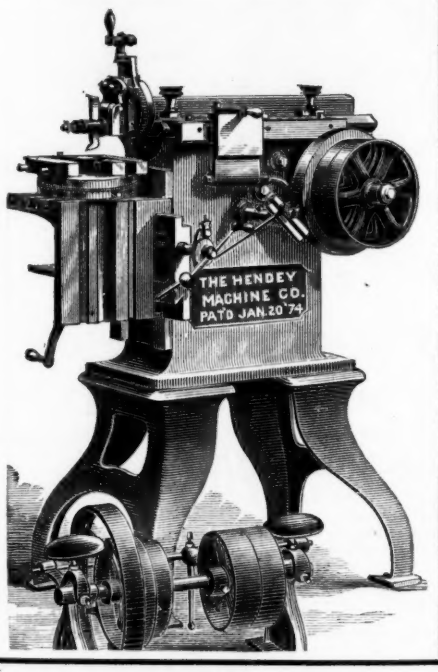

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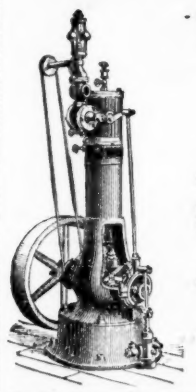

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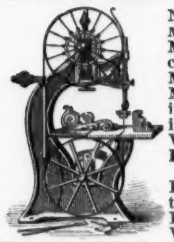

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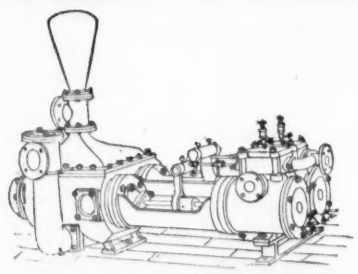

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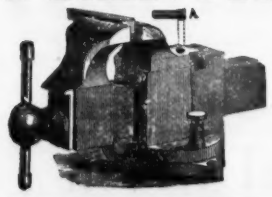

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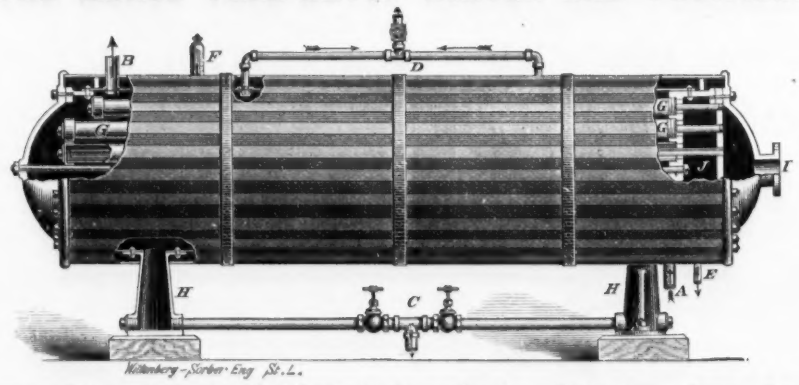

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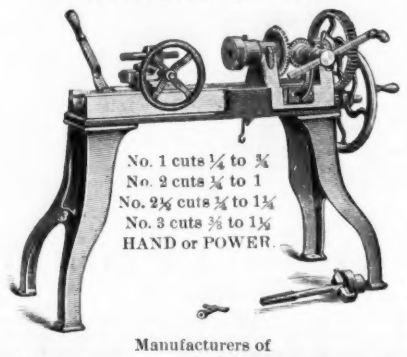

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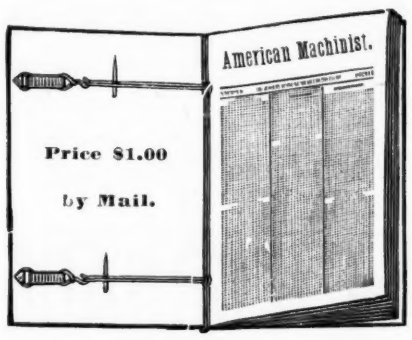

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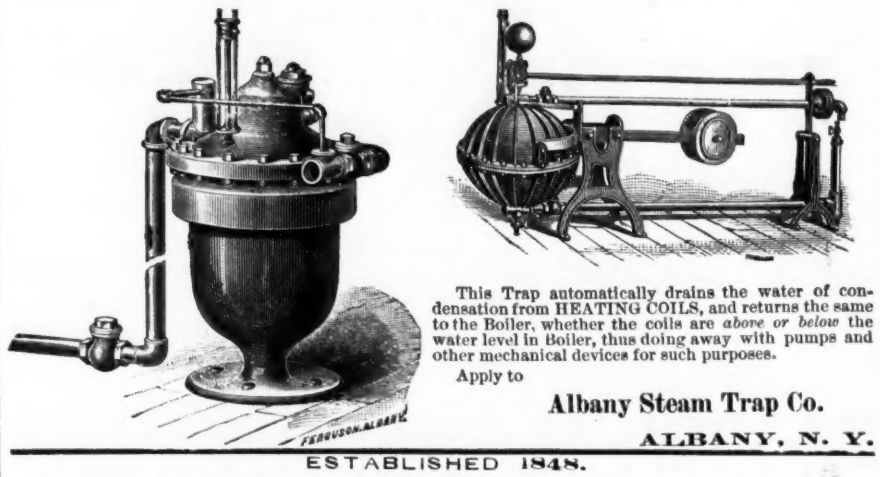

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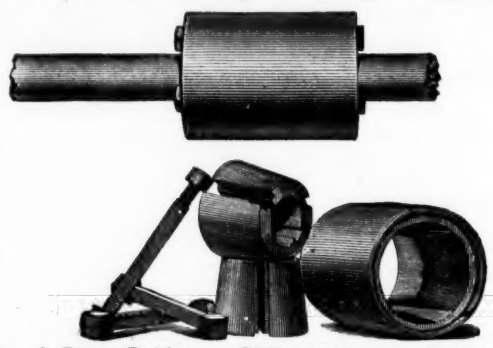

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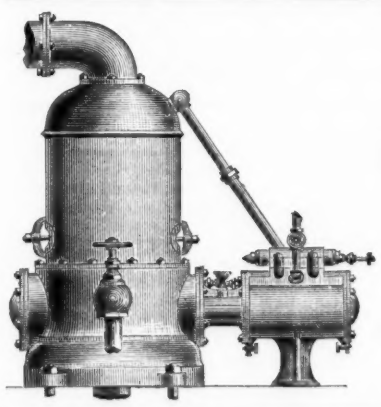

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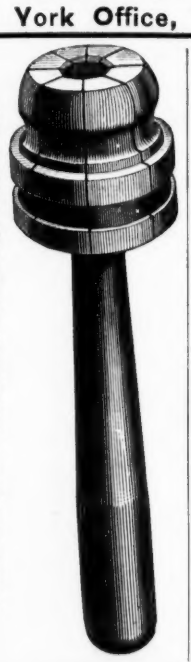

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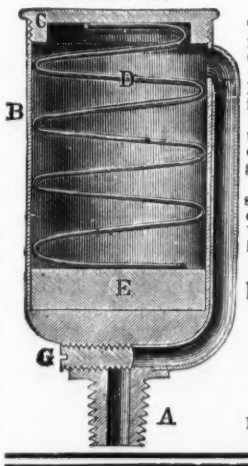

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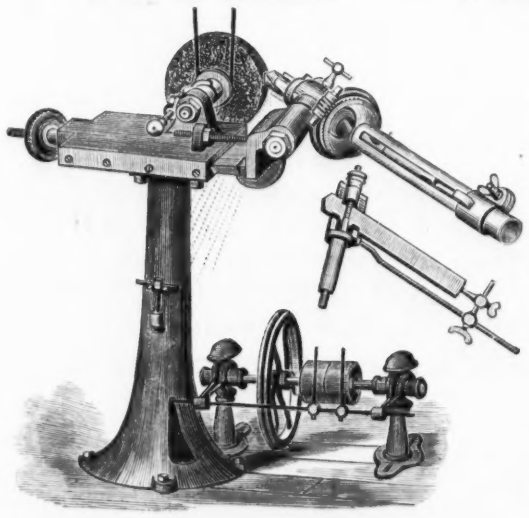

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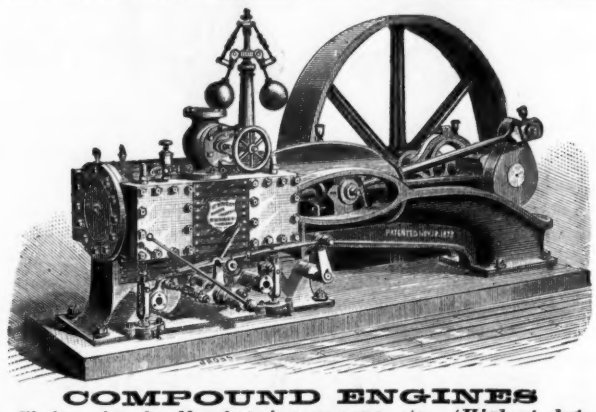

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[We desire to call particular attention to the above letter, as since it was received by us, Lieut. Mahan has confirmed his good opinion of our Engines therein expressed, by ordering two more of them.]

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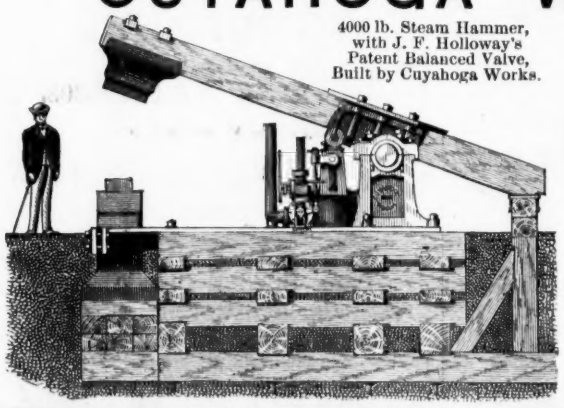

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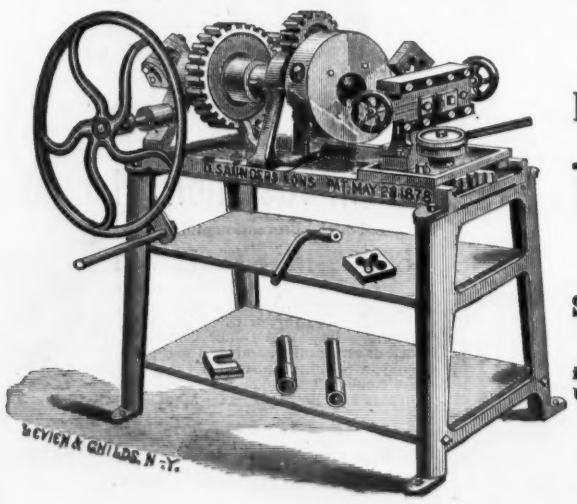

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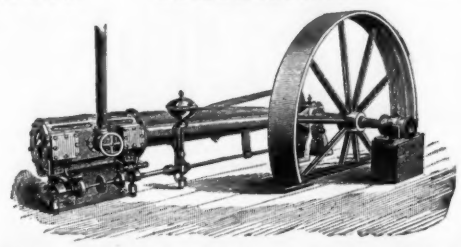

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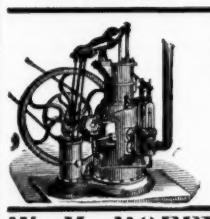

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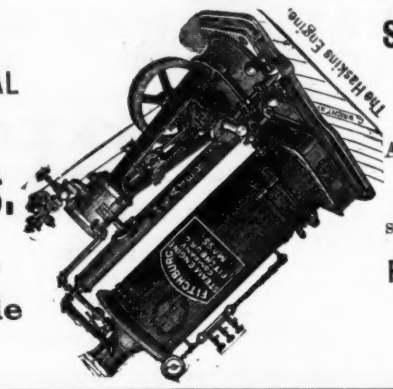

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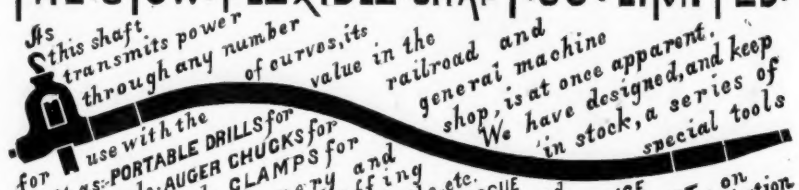
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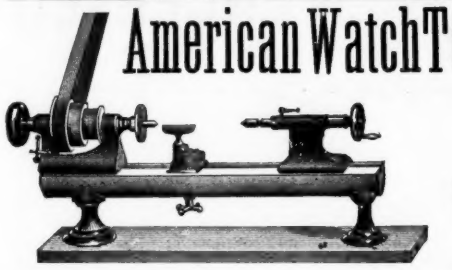

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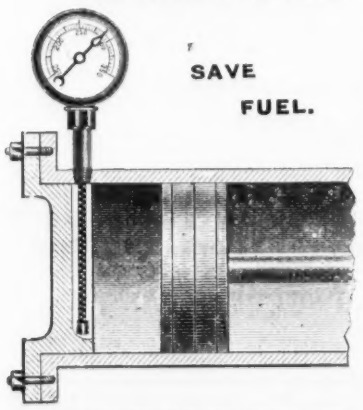

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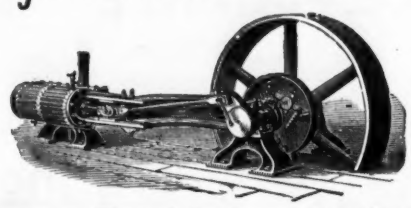

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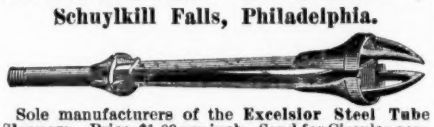

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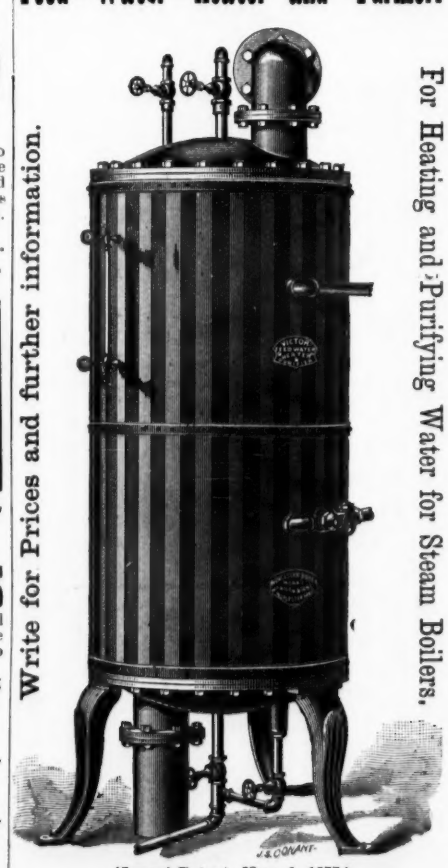

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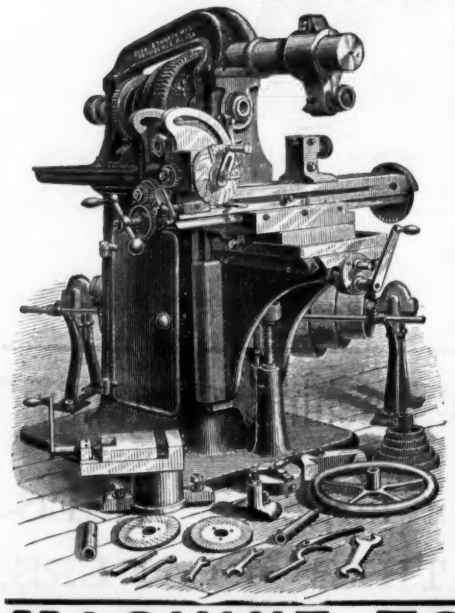

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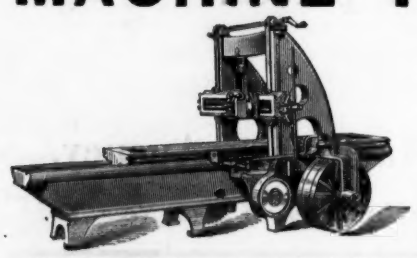

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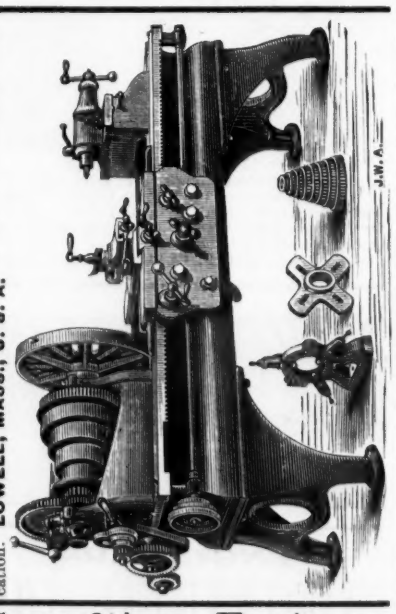

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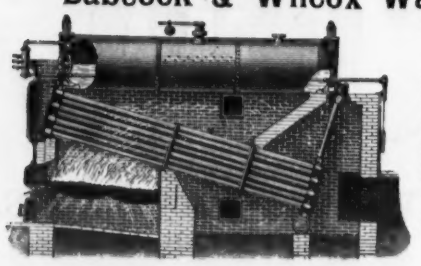

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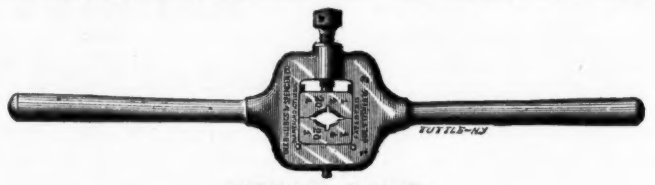

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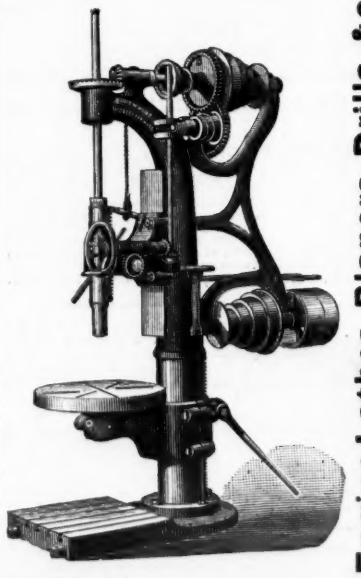

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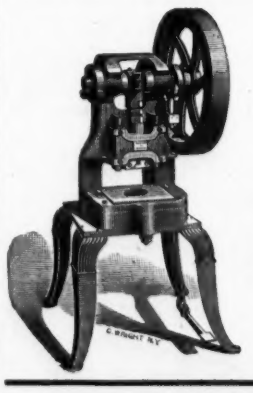

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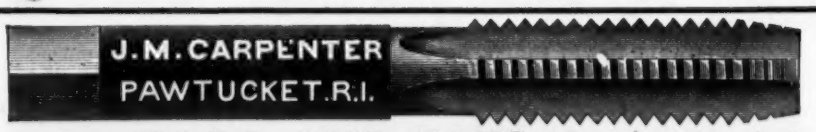

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